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BIOLOGICAL ASPECTS

OF

HUMAN PROBLEMS

BY

CHRISTIAN A. HERTER

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New York

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INTRODUCTORY NOTE

THOUGH the manuscript of this book was left in the form of a connected draft, it was not in final form for publication at the time of Dr. Herter's death. This applies more particularly to the chapters here grouped under book four, which do not fairly represent the full development of the author's thought as indicated by many additional notes, and by complete but unconnected passages by which they are accompanied. A more extensive treatment, especially of the eleventh chapter, had been planned; the substance of the two following ones was represented by three separate drafts, each of which contained a considerable amount of material not duplicated in the others. The most complete of these drafts is here printed, with the addition of a few short passages from the other two.

In editing the manuscript for the press, no essential alterations in plan or treatment have been made, but a few minor changes have seemed necessary. The five long chapters of the original draft have been subdivided into fourteen shorter ones and have been grouped in four "Books." A few passages that involved a certain amount of repetition have been omitted, a few have been altered in sequence, and

one or two statements of fact have been slightly modified, in form, though not in substance, in the belief that these changes would have been approved by the author himself. In other respects the book stands as it was written.

My thanks are due to those of Dr. Herter's scientific friends who had discussed with him some of the subjects treated and were familiar with his general views. Without their generous help and encouragement I should have found it difficult to prepare the manuscript for the press.

SUSAN DOWS HERTER.

PREFACE

This volume is based on notes begun during a trip to Egypt in 1906, when it occurred to me that a discussion of certain human problems from the biological standpoint might prove helpful to my children. It had long seemed to me that the serious student of biological processes might in time reach views respecting the mystery of life, which should throw some light on the attitude of people toward nature and especially toward other human beings. Having reached a time of life when I began to feel confidence that the laws of biology might often prove reliable guides to the understanding of puzzling situations in life, I experienced a desire to state my views to my children in a manner more definite than is possible in conversation. I am now led to publish my interpretation of biological laws in their bearing on human life in the hope that they may prove of some service to persons who have faith that an understanding of such laws is frequently a help to more intelligent and humane conduct.

I know there are still many cultivated persons who are unfriendly or actively hostile to a rationalistic standpoint in relation to ethical questions. They believe that religious teachings are the best

guide to conduct and resent the intrusion of seemingly new standards. Others uninfluenced by religious training are of the opinion that philosophic considerations are useless and that every human being has to work out his own salvation by personal experience. Both these attitudes seem to me singularly unimaginative and unidealistic. For if it is true that human beings are no exception to the rule that all organized beings are in the process of adaptation to their surroundings, is it not evident that the chief aim of conscious beings should be the intelligent and artful adaptations of each individual to his special group of conditions? But how is that possible without some understanding of the larger principles operative in the control of the body? It will not suffice to say that every person, by taking a common-sense view of life or a religious view of life, will learn to act for the best. The truth is that human problems are extremely complex and that knowledge is required to solve them. History has richly supplied us with instances of the ways in which religious teaching has been appealed to in solving human questions; it has also supplied us with sufficiently numerous examples of what happens when untrained people have been guided by preconceived ideas or have depended on opportunism and personal desire. The results, it seems to me, have not been so satisfactory as to make one feel that other guides to conduct can be pushed aside as unnecessary. The biological idea of human life is

very recent and has been little tried. Harvey discovered the circulation of the blood in 1645. Obviously biological conceptions of life previous to that time must have been too crude to have any significance for human conduct. Lavoisier in 1799 showed that combustion consists in the union of oxygen with the objects burned. This was a discovery destined to have the most significant influence on conceptions of human physiology, but imagine the state of biological thought previous to the development of this influence! Only fifty years ago Darwin published the "Origin of Species" and gave the first compelling hypothesis of the nature of human evolution from lower forms. How was it possible to form reasonable biological views of human life previous to that time? The last half century has witnessed a wonderful extension of biological conceptions in general, and people have barely begun to realize that the discoveries of this period have made it necessary to wholly revise our ideas as to life processes. But if this revision of ideas as to life in general is necessary, is it not also necessary to extend it to the special and important case of human life? We are in truth in the midst of a quiet but irrepressible and progressive revolution in thought, which cannot fail profoundly to alter men's point of view, not only of life in general, but of the nature and judgment of human conduct. Is it not reasonable to welcome any aid that biological thought may extend to us in relation to human actions;

should not this messenger too have a hearing, as well as religion and metaphysics?

Perhaps the greatest differences between human beings relate to their powers of constructive imagination, their ability to interpret the present and predict the future in the light of the past. Most persons do not possess such powers in high degree. They are occupied with the struggle to get a living, with reproduction, with eating and drinking and dressing, and with certain banal amusements. An interest in ideas for their own sake is commonly lacking. They take the static view of life rather than the dynamic, whether it be in business or politics or education. They fail fully to grasp the idea that all things living are in a state of seething flux, tending to construction or destruction. And naturally they fail to see that the tendency, constructive or destructive, is governed by quite definite laws, which the human mind may in a degree understand and even utilize. I foresee that to such minds the point of view which has been presented in this volume will make no favorable appeal, but will rather prove distasteful or even repellent.

The view of human problems which I have ventured to present is one which has its origin in the experiences and convictions of the student of biology and of disease. In the first three chapters I have tried to show in what respects the animal body may be regarded as a mechanism, and in what respects it differs from mechanical contrivances with which

we are now acquainted. The mechanistic hypothesis carries with it, by implication, the belief that the human animal is an automaton or self-regulating machine, of unfathomable complexity and extreme plasticity with respect to the influence of stimuli of external or internal origin. The doctrine of the illusory nature of the sensation of free will has its basis in this conception of the automatism of the central nervous system.

In the following seven chapters are discussed the nature of the self-preservative and sexual instincts, which in their phylogeny or racial ancientness appear to be the most fundamental of all instinctive qualities in living protoplasm. Other instincts, such as relate, for example, to imitation, affection, the love of beauty, and the awe of the powerful and unintelligible, seem to be built up on these two primitive instincts, partly through their fusion or interaction. This view is imperfectly expressed, or rather outlined, in the eleventh chapter. In the final chapters I have been so venturesome as to indicate what seem to me the tendencies in development in education, literature, music, art, business, politics, and science. Many of the ideas here expressed are put forward with much hesitancy, as the difficult questions which I have touched on so casually do not lend themselves readily to such impressionistic handling. My purpose in touching on them at all has been not so much to make correct forecasts of tendency, as to show that progress in general, whether

in art, in morals, in sociology, or in science, bears an extremely close relationship to biology and its concepts. It may be that this fact is quite well understood by many of the worthiest representatives of these subjects, but my personal acquaintance with cultivated and creative persons has made the impression that it is only here and there that the modern biological spirit has been recognized as a powerful inspiration. My own faith is so strong in the directive value of a serious biological conception of life, that I offer this essay, hoping its spirit may evoke a sympathetic response in those who, like myself, are striving, not without pain, to find a more consistent guide to those complicated personal reactions which we call conduct.

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BIOLOGICAL ASPECTS OF HUMAN PROBLEMS

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BOOK I. THE ANIMAL BODY AS A MECHANISM

CHAPTER I

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THE MECHANISTIC CONCEPTION

As we learn more about the specific conditions that attend life in the higher animals, there comes a growing conviction that the biological processes that hold sway in our bodies and condition our minds must have a controlling, though often veiled, influence on the ordinary occurrences of life. Human problems have often been scrutinized from the standpoint of religion and metaphysics and sometimes from the position of the artist, but aside from medical teaching singularly little effort has been made to glean what there is to be learned from the laws governing the physical or body mechanisms in their relation to men's acts. Perhaps the inherent difficulties in any such attempt have acted as a deterrent to the wise, since it needs no profound thought to realize that the simplest of living phenomena are far beyond satisfactory analysis by the human mind, however greatly it may be aided by the helps with which science has

so richly furnished us. The biologist recognizes that the living individual is made up of an aggregation of myriads of tiny cells, each of which is capable, in a measure, of carrying on the processes of life in a sense independently of its neighbors; and that in these cells the secrets of life are to be sought. It is the conviction and working hypothesis of foremost modern biologists that the organized material making up the living cells is governed by physical and chemical processes, and that there is now no reasonable ground for assuming the existence of a special and distinct "vital force" independent of such physical and chemical processes. Nevertheless, to picture clearly the multiplicity of chemical and physical exchanges in energy that have their seat in the individual cell is a goal which not even the enthusiastic novice in biology believes to be in sight. And the hope of obtaining a truly adequate explanation of life, such as might come only through a far deeper penetration into the secret of the elementary forces concerned with all matter, is deferred from generation to generation. But this delay is no ground for discouragement, since it is accompanied by an ever-widening and deepening insight into the nature of forces and things.

Perhaps the literary artists have been in a very different way quite as successful as the scientists in giving men a glimpse into the workings of these laws, and it is certain that the wisdom of the poet and seer and the interpretations of the novelist are equally

welcome, to the philosophical mind, with the discoveries of those who have contented themselves with the study of the more frankly mechanical aspects of life. There are signs that the scientific discoverer and the literary artist have much in common which must one day form the basis of a new sort of literature in which the fundamental qualities of nature will be handled in highly imaginative but legitimate language. The work of Henry James, of Mrs. Ward, and of Edith Wharton show unmistakable evidences of an analytical tendency traceable to the teachings of biological science. The standpoint of the literary craftsman is less fundamental than that of the biologist, for it encourages him to deal mainly with the transcendingly complex and obscure symbols of brain activity—with human feelings, emotions, and judgments. However skilfully and veritably he may depict these subtle phases of cerebral action, he leans on intuition as a guide. Shakespeare, Goethe, Meredith, George Eliot, and Emerson, despite the dynamic qualities of their artistry in psychological analyses and syntheses, might have gained in scope and precision from a better insight into the laws of biology, especially as expressed in human personality. To emphasize the evanescent in life processes, to strive for more just conceptions of the dynamical elements in human conduct, should become more and more a goal of literary activity.

However this may be, it is certain that no lastingly satisfactory conception of human conduct can be

formed without a clearer recognition of the essentially fundamental attributes of the human animal organism. People have long suspected that the human body is in truth a machine of extreme complexity of function. But that the human body should be regarded as something more than a mere machine is only natural. Yet the resemblances between the most refined mechanisms of human design and the human body are so many and so fundamental that it is no light task to trace fairly the resemblances and differences. What is true of the entire animal organism in this respect is true of each individual cell in the living body; namely, that while an ever-increasing proportion of its activities may be explained on the basis of physicochemical laws, there still remain functions that defy known methods of analysis.

I

The mechanistic conception of the animal body is essentially of modern origin. Harvey's discovery of the circulation of the blood paved the way to the recognition of the heart as an efficient force pump; and more recent studies have made it clear that a proper distribution of nutrient material and of oxygen depends on the integrity of various mechanical arrangements connected with the circulatory system. In general, the maintenance of a good blood supply is of the first importance for the

preservation of function — reduce the blood flow through the kidney, and the secretion of urine ceases; reduce the blood flow through the brain, and the loss of memory is followed quickly by loss of consciousness. Even more obvious than the mechanical features of the circulation are the mechanical principles involved in movement and locomotion. The same systems of levers that have been utilized in machines made by man come into constant use, in highly refined ways, in the animal organism. The application of such principles as these in human locomotion was well understood by Borelli, the Italian physiologist, who more than two hundred years ago published an ingenious essay on the subject ("De Motu Animalium"), in which he set forth the mathematical principles involved. Descartes, in the seventeenth century, was deeply impressed with the idea that the brain is the organ which subserves sensation, thought, and emotion, and that some alteration in the state of the matter of this organ is the regular antecedent of the state of consciousness described by the words "sensation," "thought," and "emotion." His insight extended also to a knowledge that the movements of animals depend on changes in the forms of the muscles and that these changes in form result from processes that go on in the matter of the nerves going to the muscles; and he further realized that the sensations of animals are dependent on changes in the matter of the nerves that connect the organs of sense with

the brain. Descartes concluded that animals are self-regulating machines, or automata, but strongly repudiated this idea as applied to man.

A striking indication of the validity of the idea that the human body is essentially a machine, capable of generating and expending energy like machines of human invention, was furnished by the highly significant discovery of the law of the conservation of energy. Faraday, the great experimental physicist, was on the verge of this discovery, but circumstances placed it within the ken of a German physician, Julius Robert Meyer. Observant and thoughtful, this young man while on a trip to a warm country noticed that the blood in the veins of a patient was lighter in color than is the case with the venous blood of persons in temperate or cold climates. From this little observation Meyer inferred that the lighter color meant less active oxidation in the tissues of the body, and that this lesser oxidation is just what one would expect where a lesser formation of animal heat was needed by the organism. In a cold climate the body would be compelled to make more heat, and to do this would be compelled to oxidize more intensely. It flashed on Meyer that the oxidations or combustions in the body must be the source of all animal heat. He was thus led to look on the body as a machine, and this brought him independently to exactly the same conclusion as that which has been reached by the physicist Joule; namely, to the doctrine of the

mechanical equivalent of heat, according to which a given amount of energy of motion will yield a given amount of heat, and no more. So there arose the conception that the human animal, like all animals and, indeed, all plants, is a mechanical organism directed by the same laws that govern inorganic matter and able to transform energy, as from heat into motion or from motion into heat, though unable to create new energy. At the same time the chemist Liebig confidently put forward the doctrine that oxidations go on in the body, not, as had been supposed, in the lungs, where the oxygen is drawn in, but in the tissues, where the oxygen is carried by the blood stream. To-day it is universally recognized by physiologists that the body machine converts the potential energy of food into two main forms of energy, — animal heat and motion, — as the steam engine utilizes the energy which comes from the burning of coal or wood.

Any consideration of the processes of combustion within the living organism brings us face to face with a question of large, general significance: Does the law of the conservation of energy hold good alike in the humanly produced engine and in the animal body? It would be aside from our main purpose to dwell on this highly interesting question. But it is important for us to realize that the many experiments which have been made to settle this question justify us in concluding that the law of the conservation of energy is equally true for engines of human

make and for living animal mechanisms. Great difficulties attend the testing of this question in the animal organism, owing to that complexity which arises from the interaction of the numerous processes that go on simultaneously and side by side. As the result of this complexity we cannot test the law of conservation as we can test it in simple machines, for we have to make various disturbing allowances for interferences of many kinds. Nevertheless it is safe to regard it as a practical certainty that the doctrine of conservation holds good for living animals. The human machine is superior to all engines in the extent to which it utilizes the power stored in its sources of energy. This superiority depends largely on the better absorption of heat generated by combustion. Owing to the conditions of combustion in the living body, this absorption of heat approaches the ideal level; owing to the crude conditions of absorption in the artificial machine, there is an enormous loss of energy which human ingenuity has never been able in practice to correct. Doubtless an artificial engine could be so constructed as to overcome this fault, but it would be a scientific curiosity and not a practical source of energy.

A beautiful example of the mechanical principle which subserves a highly refined function of the body is to be seen in the relations of the crystalline lens of the eye to the formation of visual images on the retina. The physical and mathematical laws governing the formation of these images were admirably

worked out by Helmholtz during the middle of the last century, and have required little amplification. The resemblance of the mechanism of the human eye to a photographic camera is so close that only a dull mind fails to see it. The analogy pertains not merely to the crystalline lens, but to the extremely sensitive receiving mechanism of the retina.

In 1840 Kühne, the Heidelberg physiologist, discovered the singularly sensitive and unstable substance known as the retinal red. This evasive substance, so easily destroyed by the ordinary methods of chemistry, apparently forms an evanescent, constantly renewed layer in the retina. This layer, although not essential to sight in all animals, nevertheless seems to sensitize the retina to the rays of light which fall on it after convergence there through the crystalline lens. The retinal red is thus the analogue of the light-sensitive film of a photographic plate. It is clearly the basis of a process in which chemical changes are prominent. And not merely does this wonderful substance in some way aid vision, but it also gives us a possible intimation — a vague one, but the most definite we have — as to how certain layers of nerve cells in the brain may be sensitized to the reception of some sorts of sensory stimuli through the agency of chemically unstable substances. Another instance of a living mechanism which has its physical parallel outside the body is furnished by the structures concerned with hearing. The eardrum has a close analogue in the vibratory

diaphragm of a telephone receiver. The auditory records or memories in the nervous system bring to mind the continuous records made on the tinfoil of a phonograph. But the revival of the tracings of the phonograph, implicating as it does a process purely physical in its nature, must be very different from the reawakening of memory through the chemical processes which we must assume to underlie nervous activities. Yet there attaches a deep interest to the idea that the brain may contain materials which fixate in some definite though subtle material way the impressions which act on them; and moreover in such a way that the materials concerned in this fixation may on occasion be rearranged so as to revive the original impressions. The relatively crude physical analogy of the phonographic tracing is welcome, for it is now the only one we have and may prove the forerunner of knowledge of chemical parallels.

II

Enough examples have now been cited to show some notable similarities between animal organisms and artificial machines. These similarities are sufficiently profound to create a strong presumption that there are many other resemblances, perhaps less obvious but equally instructive as bearing on the mechanistic hypothesis. Research has, indeed, brought to light an immense body of additional facts

favorable to the mechanistic or physicochemical view of life. It is possible to consider here only a small number of these facts, and it seems best to think of these in relation to the most obvious differences that exist between the animal mechanism and the organized products of human inventiveness. If we think of our evidence in this way, we shall be better able to perceive the strength or weakness of the mechanistic conception. There are four properties of living organisms which distinguish them with the utmost clearness from even the most complex mechanisms of human make. These properties are, first, the peculiar chemical constitution of the basic material or protoplasm of which the living cells are composed; secondly, the powers of metabolism or simultaneous upbuilding and breakdown of the living protoplasm; thirdly, the power of reproduction; and, finally, the power of growth and all that this implies in respect to a regulative influence over the living material.

Let us consider, first, the known physical and chemical properties of the living protoplasm. This useful term bridges immense chasms in our knowledge. The substance which fills the living cells has no uniformity of physical or chemical constitution, for it varies considerably in different kinds of cells. But it has certain distinctive properties which stand in the most intimate relation to the things which living cells do. Both the physical and chemical properties of protoplasm are in the main due to

the properties of the proteins of which the protoplasm mainly consists. The proteins are substances of a colloid nature, that is to say, substances which do not permeate animal membranes at all or only with the utmost sluggishness. The colloid character of the proteins imparts to the living protoplasm a high degree of physical stability and enables unlike chemical processes to be carried on side by side in the living cell, without risk of interference between the minute foci of action. If we study the living protoplasm with the microscope, we can see features of structure which speak for the view first expressed by Bütschli — that protoplasm has a foamlike structure. There are reasons for believing that there is a close physical analogy between foams and emulsions, and the colloids lend themselves readily to existence in both these states and to the solid and liquid conditions on which emulsions and foams depend. An extremely significant feature of the colloid property of undergoing minute subdivision is the fact that the very extended surface so generated is a powerful aid to chemical activity. The intense chemical activities of living protoplasm are doubtless made possible by this accelerating action of widely extended yet contiguous surface. Chemistry furnishes us with a gross analogy which may be cited in this connection. If we pass ammonia gas through a porcelain tube heated to 1000° C., there occurs a moderate decomposition of the gas. But if we repeat the experiment, using

a tube filled with finely divided porous bits of porcelain, the ammonia is decomposed into its constituent nitrogen and hydrogen even at a much lower temperature.

The essential material basis of living things is called protoplasm. The basis of protoplasm appears to be the material known as protein. Dead protoplasm and protein are not identical, for the cell contents embody many small particles of lifeless matter which have a different chemical constitution from that of protein; for example, glycogen, fats, fatty acids, and other substances of physiological importance. The cell contents hold also the enzymes which are so active in effecting chemical changes. Although the enzymes probably share the chemical nature of protein, they must be thought of as something quite distinct from the protein masses which make up the greater part of the living or dead protoplasm. The chemical nature of these constituent masses appears to determine in large degree the character of the protoplasm.

The proteins vary in chemical constitution within rather wide limits. We know that the protein molecule is always of great size as compared with the sugar molecule or the fat molecule, and it is clear that its colloid properties depend on this. It is quite beside the present purpose to discuss the chemical nature of the proteins. The exact grouping of the various kinds of atoms in the most complex proteins is still wrapped in darkness despite important

gains in knowledge. Of the simpler proteins more is known, and the chemical components of some of the simplest are established. What concerns us here is the fact that some bodies related to simplest proteins have been made by chemical synthesis. In 1829 the noble-minded German chemist Wöhler convinced skeptical scientists that he could make urea from ammonium cyanate. This was an epoch-making discovery, for it showed that the chemist can synthesize an organic substance formed in nature by the animal body only. Now we have been shown by Fischer that certain natural proteins can be made in the laboratory. Yet this admirable achievement leaves a wide gap to the synthesis of living protoplasm. It is certain that no one has yet transformed dead into living matter. The satisfactory synthesis of higher proteins would be a step, but only a step, in the right direction. It is true that Verworn has defined life as the metabolism of proteins, but the conception is patently inadequate. In order to feel sure that success has been reached in converting dead into living matter, it would be necessary to show that the artificial substance is capable of growth and reproduction. For me it seems inconceivable that any artificial product should be capable of reproducing and growing, since these functions imply an organization based on hereditary experiences, memories, and processes which there is little hope of blindly imitating. Brooks eloquently, if not convincingly, touched the heart of the difficulty

when he said: "The essence of life is not protoplasm, but purpose." Yet we see about us animals and plants which are continually changing dead into living substance. That these transformations are accomplished by the aid of perfectly definite physical and chemical mechanisms is a reasonable belief, and there is no doubt that much is to be learned by the further investigation and imitation of these natural processes. But we must not forget the possibility that life has never had a beginning at all, or that it is as old as matter itself. To so good a mind as that of Helmholtz this seemed a not unreasonable view. And Helmholtz asked "whether seeds have not been carried from one planet to another and been developed everywhere where they have fallen on a fertile soil." This hypothesis of panspermia has latterly been ingeniously extended by Arrhenius and deserves serious attention.

Thus we see that the origin and nature of living protoplasm is veiled in the utmost obscurity. For many investigators this obscurity seems so serious as to discourage attempts to create living from dead material; others, however, feel that it is essential to continue to make trials in this direction, if only in the hope of incidentally gaining a deeper insight into living processes. What here especially concerns us is that even if the attempts to make living matter should ultimately fail, this failure would not necessarily compel us to abandon a mechanistic hypothesis of living material. In other words, the

circumstance that we cannot create living matter would be no proof that such matter did not originally come into existence through the play of physical and chemical agencies or other natural forces.

We may now consider the second feature which distinguishes living beings from artificial machines — the power of metabolism. The metabolic power consists of the ability of the living protoplasm simultaneously to build up some materials (living or dead) and to break down others. These processes of metabolism must be pictured as keeping the cell contents in a continual state of flux. In youth the constructive processes preponderate over the destructive; in old age the destructive processes are more active than the constructive; in adult life there is an approximate balance between the forces that upbuild and those that break down. It has been already mentioned that ferments or enzymes play a large part in the chemical processes of the body. This holds true both of the upbuilding or synthetic processes and of the destructive ones. Physiologists are now agreed that there are enzymes which break down sugars, enzymes which break down fats, and enzymes which break down proteins. In recent years there has come to light a singular and unpredicted property of these enzymes. This is the reversibility of their action under special conditions. Croft Hill showed that under certain conditions the sugar-splitting enzymes can combine two molecules of a simple sugar into one molecule of a

more complex one; Kastle and Loewenhart caused a fat-splitting enzyme to form the ethyl ester of butyric acid from butyric acid and ethyl alcohol; Taylor succeeded in making a protein-splitting enzyme (a special trypsin) build up a simple protein from its cleavage products. That the same enzymes which break down sugars, fats, and proteins may, under suitable conditions, reverse their action so as to construct the more complex molecules from simpler ones, is a conception of the very first importance for biology. Obviously it gives a substantial clew to the way in which living protoplasm is built up in the course of ordinary metabolism and during the process of growth.

The breakdown of protoplasm and foodstuffs in normal metabolism is accomplished in part through the agency of oxidation, which may properly be regarded as typifying the most fundamental kind of chemical processes in the living cells. It has been indicated that there is a resemblance between the combustions in an engine of human make and the combustion of food by living animals. Let us discuss this resemblance further. For if it can be shown that the resemblance is essentially superficial, this must be admitted to be inimical to the mechanistic hypothesis; whilst the detection of an essential identity of action in the two cases must be regarded as a significant support to this view. The serious discussion of this question is hardly possible without reference to some technical details of a chemical

nature. On account of the definiteness and importance of the evidence so obtainable I prefer to risk the introduction of some unfamiliar facts rather than the exclusion of highly significant evidence.

The cells of the animal body are mainly nourished by taking up three kinds of foodstuffs which are widely different in their chemical character. These foodstuffs are, first, the nitrogen-holding complex compounds which we call proteins; second, fats; and third, the carbohydrates. When acted on by certain enzymes or ferments, the substances belonging to these groups are split into somewhat smaller molecules and take up the elements of water. This process is known to chemists as hydrolysis, and the products of the splitting are called hydrolytic products. Oxidation in the animal body relates mainly to the hydrolytic products of the proteins, the fats, and the carbohydrates. It is from the oxidation of these substances that the living animal organism derives most of its energy.

How are these various oxidations in the animal body to be explained? The remarkable thing about them is that they go on so energetically at the low temperature of the animal body. It is obvious to any one who thinks at all on the subject that the free oxygen of the air does not oxidize any of the common foodstuffs when these are exposed to its action. It is true that there is some evidence that the fat deposits of Egyptian mummies show a moderate degree of oxidation, which can probably be attrib-

uted to the access of the oxygen of the air during thousands of years. But this action is so slight that it has no real bearing on the oxidations here in question. Equally inactive is the oxidized hæmoglobin of the blood, known as oxyhæmoglobin. It has long been clear that to account for the animal oxidations we must seek for oxidizing agents in some cell constituents which get their oxygen from the oxyhæmoglobin of the blood. The difficulty of investigating these oxidizing substances is very great and their exact identity still remains unrevealed. Yet there are many signs that these substances have the nature of unstable peroxides. It is known to chemists that many reactive substances, such as benzaldehyde, combine with the ordinary oxygen of the air to form peroxides. These peroxides can give up part of their oxygen and so effect oxidations which otherwise would not occur. It is reasonable to suppose that the oxidizing enzymes or oxydases of the animal tissues are similar in type to the peroxides just mentioned.

If this hypothesis were true, one would expect to find a similarity between the types of oxidative change brought about by tissue oxidases and the types induced by artificial peroxides. In the course of experimental studies carried on by Dakin, a comparison has been made between the action of the simplest artificial peroxide — hydrogen peroxide — and the action of the living animal tissues. This comparison reveals a singularly close analogy in the two cases.

It is not claimed that there are no differences, but it appears in a high degree probable that these differences are ones of degree and not of essence or type. What we particularly miss in our laboratory imitations of the animal oxidations is the regulation of the stages of combustion. But these differences are doubtless due to the complexity of the organic oxidizing ferments or enzymes and probably to their specificity. We know that when plant bacteria fix nitrogen for the use of plants they do so by stages. One group of bacteria oxidizes the nitrogen to nitrites, and a distinct group oxidizes the nitrites to nitrates. These bacteria doubtless work by means of oxidative enzymes or oxidases and thus afford us a suggestive illustration for the differentiation of oxidative labor that probably goes on in the living cells.

A third feature of difference between the animal organism and the mechanism of human make is the power of reproduction. Clearly the process of reproduction has no analogy in the world of unorganized things. The process cannot be explained on any mechanistic or physicochemical grounds at present within our ken, even in the case of the simplest process of reproduction, as where a yeast plant divides by budding and fission. In the case of reproduction in the higher animals the changes in the egg cell that attend and follow impregnation are of an extremely complex nature, and it can hardly be considered surprising that the dynamics of cell division should be wrapped in obscurity. But the

microscopical appearances within the egg during the period of cell division are such as to suggest that quite definite physicochemical processes have been set in train by the action of the sperm. There are numerous indications, which need not be put forward, that specific enzymes are concerned in prominent and even determining ways with the entire mechanism of cell division. The *very narrow limits* within which these processes of cell division occur make it extremely difficult to investigate the chemical aspect of the problem. Yet even here there are signs of progress, and it seems not unreasonable to hope that human ingenuity will one day provide the conditions for the serious study of the chemical forces inseparably bound up with this problem. In other words, we may say that despite our present ignorance, the reproductive process in the cell shows morphological and other signs of resting on physicochemical forces. How far these or other natural forces will be shown to be responsible for cell division no one can say, but it is reasonable to expect great advances in the direction of an increasingly refined and more adequate understanding of these forces.

A fourth distinctive feature of the animal organism is its capacity to grow. A highly noteworthy thing about this capacity to grow is the evidence of definite regulation of the growing parts. This regulation is so orderly and precise as to excite wonder and admiration. How does it happen that the various

parts of the body assume definite forms and sizes? Why does the skin of the human thumb assume markings so sharply defined as to be in a singular degree characteristic of the individual — sufficiently so, indeed, to serve in fixing the identity of criminals? How is it that the cells forming the nose of a child arrange themselves into an organ closely resembling in every detail that of a parent, instead of assuming a quite different form and size? The clew to such questions is doubtless to be sought in properties possessed by the well-defined rod-shaped masses of matter in the nuclei of the germ cells at the time of fertilization, which are known as *chromosomes*. These are now generally recognized to be at least an important factor in hereditary transmission, as will be pointed out in discussing the law of Mendelian heredity and the recent developments of biological science in relation to sex. But none of the facts now known to us shed any real light on the *way* in which the forces of regulation are operative in the growing cells. The instances of regulation of growth which I have just cited are sufficiently puzzling. But they are at least referable, as already stated, to an hereditary mechanism of some sort. There are, however, still more enigmatical cases. I will cite the case of the regeneration of the lens of the eye in the tadpoles of salamanders, — a case which has been assumed by some biologists to be incapable of mechanical explanation. If we remove the crystalline lens from the eye of the young salamander

tadpole, the animal soon forms a new one, thus making the eye apparently as efficient as before. That there should be a regeneration of the lens at all is, of course, in itself a notable thing. But in this case there is something more to consider than the fact of regeneration — something which presents the embryologist with an extremely puzzling problem. For the new lens is not made in the same way or from the same kind of material as the old one. In normal development the lens is formed from the outer skin, or ectoderm, of the head. When the lens is regenerated, it is built up by cells from the iris, which forms the edge of the optic cup, and this originates in the embryo as an outgrowth from the brain itself, and not from the outer skin. Neither the animal itself nor any of its ancestors can reasonably be supposed to have become habituated to such a method of regeneration. It is therefore difficult to see how such a singular power as this can have been acquired and how it can be a potential quality in the cells of the organism. Some naturalists are disposed to attribute these properties to some sort of intelligent purposive action. But if this is really the case, why do the higher animals and man lack the help of similar favoring activities? The truth is that the supporter of the mechanistic view of life is brought to a standstill by questions of this nature in the sense that he can see no hope of solving them in the near future on the basis of any known physico-chemical forces. Writers who have felt this diffi-

culty have urged that we must call in to our aid the supposition that there is something analogous to a form of intelligence, which regulates and controls growth and life processes generally. Views of this sort signify a return to a vitalistic type of doctrine, and differ from older views mainly in the definiteness of the evidence that seems to compel their adoption. They may properly be thought of as constituting a "neo-vitalistic" teaching. But this teaching, like all vitalistic doctrines, impresses us with its unsubstantial or negative quality. It reminds us of the words put by Goethe into the mouth of Mephistopheles, "Und gerade da wo die Begriffe fehlen stellt sich zur rechten Zeit ein Wort herein."

What should be the attitude of those who seek the truth regarding this neo-vitalistic doctrine — this modern and legitimate representative of an idea that has occupied the attention of thinking men in every period of history? The question whether the animal organism is merely a machine like an engine or clock, dependent on physicochemical forces, or is "animated" by a specific "vital principle" or "vital force" is surely one of the most momentous in its relation to man's place in nature. In our brief review of the resemblances and differences between the animal mechanism and the machine of human make, we have been brought face to face with two incontrovertible facts of the largest significance. On the one hand, it is quite clear that the body *is* a machine. Not only does it make use of the simple

mechanical devices such as levers, pumps, and valves, but it apparently obeys the universal law of the conservation of energy. The fundamental processes of oxidation in the body pass through essentially the same stages as in the case of oxidations under the control of the chemist. We may thus go so far as to say that some animal processes even of an elementary sort are explicable on the basis of physical and chemical laws. But on the other hand, we are confronted with occurrences in the animal body which at least temporarily put an obstacle in the way of our progress along this path. We are, for example, unable to offer even a remotely satisfactory solution of the directive activities which we see at work. Does this situation make it necessary for us, as persons honestly in pursuit of truth, to give up the mechanistic hypothesis of life and declare ourselves to be vitalists? I believe we are by no means in this position. The reason we are not in this position is because science is progressive, and while there is progress it is undeniable that there is a possibility, be it ever so remote, of reaching a satisfactory explanation of vital phenomena,— that is, an explanation in accord with recognized laws of nature. The history of physical and chemical discovery since Lavoisier and Faraday, and biological discovery since Schleider and Schwann, Baer, Darwin, and Pasteur, forces us to admit that the events of the nineteenth century have made a revolution in men's minds. The discoveries of that

century have made it possible to understand phenomena of life to which the eighteenth century furnished no clews. Immanuel Kant was utterly hostile to the mechanistic conception. In an oft-quoted passage he says: "It is quite certain that we cannot become adequately acquainted with organized creatures and their hidden potentialities by means of the merely mechanical principles of nature, much less can we explain them; and this is so certain that we may boldly assert that it is absurd for man even to make such an attempt or to hope that a Newton may one day arise who will make the production of a blade of grass comprehensible to us according to natural laws that have not been ordered by design. Such an insight we must absolutely deny to men." But Kant elsewhere admits that comparative anatomy gives us a ray of hope that something may be accomplished by the aid of the "principle of the mechanism of nature." Would not Kant have consistently widened his expression of hope had he been in possession of the facts of biology that are known to us to-day?

We have, indeed, not yet reached the time when reason compels us to embrace the hypothesis of a vital force. So long as the biological sciences advance, new territories are certain to be reclaimed from the gossamer kingdom of vitalism. If it ever happens that science ceases to make new discoveries in biology and the human mind ceases to grow in capacity, the time will have come to turn seriously

to vitalism. If we accept vitalism in the present state of science as a substitute for the mechanistic hypothesis of life, we must do so with the knowledge that a stimulating working hypothesis is being displaced by one which holds out no helping hand to the investigator. For we cannot look on a belief in vitalism except as an act of faith. The conception is too vague, too inexpressible in terms that are clearly intelligible, to serve as a real aid to the progress of scientific thought. There is little room for doubt that the mechanistic theory is the one which now best serves the interests of humanity. And it seems to me this position is defensible even if one is prepared to admit that there is little probability of the human mind being able to resolve finally the phenomena of life and matter. For this admission does not imply that living organisms are not in all respects mechanisms. The failure to understand all the forces at work in the mechanism may perhaps be due to the limited grasp of human faculty. And it is especially in the reconstruction of the phenomena of the present from the occurrences of the past that the human mind falls short.

Those who are disposed to turn towards vitalism in order to get a better explanation of the properties of living matter should not overlook the limitations that bound our understanding of the forces that dominate the inorganic universe. So long as we have no real explanation for facts so elementary as the contrast between the solubility of calcium chloride

in water and the relative insolubility of calcium carbonate, it cannot be said that our grasp of physicochemical forces is all-embracing. Hence we should not be hasty in assuming that physicochemical forces do not explain the phenomena of life. All we can say is that what we now know of them fails fully to explain these phenomena. The increasing profundity of scientific research warrants us in confidently predicting the discovery of new physical and chemical energies, or at least new phases of such energies. Biological knowledge began with anatomical observations. Early histological studies seemed to promise more for a deeper insight than anatomy alone could give. The cell theory of Virchow raised hopes that we should see yet deeper into the organization of living matter. But soon the methods of studying structure were taxed to the utmost without a corresponding gain in the depth of our understanding. Then it became clear that the study of the organization of the cell must include the study of the operation of physical and chemical forces within the narrow limits of the cellular structures. Noteworthy advances rewarded the pursuit of such studies. Yet the most advanced biologists are by no means satisfied with the application of existing chemical and physical methods. This is shown clearly by a strong desire to utilize the newest conceptions of matter, which deal not merely with the forces exhibited by atoms as such, but with the energies that govern the properties of particles

smaller than atoms — the electrons or corpuscles. So long as the point of view in biology continues to deepen without intermission, is it unreasonable to believe that the most satisfying explanation of life will ever be one which has its basis in the operations of natural forces?

III

Let us now turn aside from the main current of our discussion of the animal body as a mechanism, in order to glance at the analogy offered by this doctrine to large groups of human beings living under the conditions of organized society.

The human body has many times been compared with a republic in which the component parts, while living largely independent existences, live for the good of the whole. Despite the fact that the comparison is one which quite fails in several important respects, it is not without the merit of verisimilitude in some directions and offers a suggestive means of exhibiting certain peculiarities of bodily organization. The comparison demands that the different types of cells in an individual be likened to the various types of workers in a state. But the similarity between worker and cell obviously breaks down in at least two important directions. Not only do all the workers of a state constantly shift their position with respect to each other, but what is still more important, they are at liberty to alter their occupa-

tions from time to time. In the cell republic the greater number of the living elements or cells maintain approximately the same position with regard to each other. Relatively few types of cells are ambulatory. Moreover, the cells are definitely committed to their occupation; once a liver cell, always a liver cell. This arrangement, so clearly in the interest of efficiency, is one which the builders of states might do well to ponder and perhaps to imitate. There is another striking contrast. The maintenance of the state is, broadly speaking, dependent on the use of the reproductive powers of the individuals which comprise it. The maintenance of the human individual depends, indeed, on a power of renewal possessed by the individual cells. But many types of cells have only a feeble or questionable power of reproduction. For example, neither nerve cells nor muscle cells regenerate if injured, except in an imperfect way. And not only must the life of the individual come to an end, — which theoretically need never happen to a state, — but the reproduction of the individual is intrusted to specific cells that have been set aside for the purpose.

Yet the comparison between state and living body holds good in several noteworthy ways. There is, first of all, a remarkable subdivision of labor. In the animal body are represented parts or cells which govern and coördinate, parts which prepare and transform foodstuffs, parts which act as carriers

and distributors of materials which yield energy, parts which get rid of waste materials, and still other parts which have the function of ridding the organism of injurious invaders. Each of these functions has its counterpart in a variety of labor done by a citizen. Now it is clear that division of labor is inseparable from interdependence, alike of the types of workers that make a state and of the cells that compose a living body. As the various kinds of factories make different things necessary to the healthful life of a community, so do various special kinds of cells make substances required by other parts. The cells of the adrenal glands, of the pituitary gland, of the thyroid gland, of the sexual glands, of the duodenal mucous membrane, and of the pancreas, each make substances essential to life or needed for the normal maintenance of the body. In return, these cells get not merely their food from the blood, but in some cases also substances of a very special character needed for the performance of their special duties. The waterways, the roads, and the railroads may be roughly likened to the lymphatics and blood vessels. They are the necessary channels for the exchange of commodities, on the one hand, and of nutritive and waste substances, on the other. Just as the prolonged obstruction of the roads and railroads of a district may give rise to famine and possibly depopulation, so the obstruction of an artery (where there is no compensatory flow of blood through other arteries) gives rise to a

cessation of metabolism in the tributary parts and may even cause local death of the tissues.

Perhaps the most significant likeness between a federal state and a living body lies in the organization of government. A central governmental organization of much complexity, connected with subsidiary and similar organizations which ramify by telegraph to the remotest governed parts, typifies the central nervous system, the sympathetic systems of ganglia, and other ganglionic systems connected with nearly all parts of the body through the agency of nerves and nerve fibers. Being continually informed of the needs and conditions of all its parts by means of stimuli carried centrally through sensory pathways, the central nervous system makes adequate response through the agency of those structures which preside over the muscles, the blood vessels, the glands, and other parts of vital importance. Through the agency of consciousness the muscular system is brought under a nice control and innumerable fine adaptations are learned and constantly practiced. By means of an indescribably intricate and labile mechanism the nervous system integrates and coördinates sensations and feelings in such a way as to regulate beneficially the relations not only of the various parts to each other, but also of the entire individual to its surroundings. In other words, the nervous mechanism typifies in its activities at once a ministry of the interior and a ministry of foreign affairs. Notable is the even

tenor of this nervous control, which is rarely exerted in the interest of the organism as a whole. There is here an automatic consistency of action, usually without discernible favoritism or neglect toward any part, — a consistency which might well be taken as a standard for emulation in the government of a state.

Although the nerve cells and their prolongations quite obviously constitute a numerous ruling caste, the functions of the other cells are so apportioned as nowhere to reveal any dependence that can be construed by the human mind as a sign of specific inferiority. In other words, all types of cells are so essential to the prolonged welfare of the entire organism that none suffer in dignity through any comparison. Yet it is undeniable that the nerve cell, so labile and varied in its actions, so shrouded in the mysteries belonging to the transcendent function of consciousness, so inapproachable in its chemical dynamics, excites a livelier interest than a bone cell, or even a kidney cell. On the other hand, a careful consideration of the nature of these different sorts of cells shows that each type has its compensating features. The very reactivity of the nerve cell exposes it to injury. When once a deep-seated injury has been inflicted on it, the nerve cell recovers but imperfectly, for its powers of regeneration are slight. This limited power of regeneration is connected with the extremely elaborate differentiation of organization in the nerve cell. For the

nerve cell in becoming so highly specialized in some directions has lost the primitive power of reproduction, — a power which is inherent with types of cells that have become less highly specialized. Contrast with these properties of the nerve cell the properties of the kidney cell. Here we have a cell of epithelial type, retaining the powers of regeneration which in so remarkable a way pertain to epithelial cells. If the secretory cells of a healthy kidney are damaged, the injured elements are soon thrown off and replaced by new ones. Only long-continued and deep-seated injury leads to an exhaustion of this power of regeneration. But, on the other hand, the retardation of this regenerative capacity is compensated by the comparatively low specialization and differentiation of the kidney cell.

In the relationship between the governing parts of the animal organism and the parts governed there is a singularly beautiful feature of reciprocity. The central nervous system, or federal government, confers on the organism a highly beneficent protective action which is unceasing. Always alert, the governing nervous centers attend not merely to the needs of the various parts of the body in health, but stand ready to send succor to such parts as may suffer injury of one kind or another. By virtue of the superior gift of consciousness the organism is constantly being guided so as to secure to itself the most varied advantages while escaping equally varied dangers. In return for these inestimable

services the different non-nervous cells of the organism give something more than a prompt and blind obedience to the behests of the governing caste of cells, for they supply the nervous structures with an abundance of food and oxygen, and promptly relieve the governing structures of the incubus of waste products. Indeed, the body as a whole shows a kind of preferential attitude toward the nervous system in supplying the brain with a full amount of blood and oxygen even when a weak heart or defective volume of blood causes other parts to suffer from both lack of blood and lack of oxygen. There is here apparently a kind of automatic recognition of the services of consciousness to the organism. But this is not all. The discriminative action is not limited to foodstuffs and oxygen supply. It extends to a striking protective action in respect to poisonous substances. Even in a state of health the body is flooded during digestion with substances very injurious to the nervous system; and in disease there may be an acute or chronic intoxication. But before the nervous system is permitted to suffer, the body uses its utmost resources to destroy or detoxicate or eliminate the poisons in question. Liver cells, kidney cells, and white blood cells are called into action to the fullest possible extent, and the body offers them up freely to sacrifice in order to screen that part of its mechanism which is at once the most sensitive and the least capable of making a direct defense.

Thus we see in the organization of the animal body a perfection of supplementary and reciprocal relationships between the various and unequally differentiated parts which must excite not merely admiration but reflection. For may it not be true that the organization of a federal state can profit by applying to itself some of the methods of control which have been so slowly and painfully developed in the federation of structures which we have before us in any one of the higher animal forms? It is certainly true that nature has wonderfully succeeded in securing adaptation between cells having widely different properties and vital interests, and that these have been harmonized for the good of the whole. Probably in the course of evolution those parts which have not been susceptible of adaptation for the benefit of the individual have been slowly eliminated, and is this not almost certainly true of the unadaptable and unsocial individuals of a community?

As regards the form of governmental control in the animal organism, there is one additional feature which seems worthy of note in relation to the analogy which has been drawn. The animal organization has been likened to a federation or republic. The comparison holds good in so far as the body is made up of interdependent parts which are in definite ways common tributaries and subordinates of the central nervous system. But the relation is not so simple as this. It has already been pointed out that

a fully developed cell never changes its character under normal conditions. Now it is also true that the different adult cells have different origins in an embryological sense. Early in development there is a well-known differentiation of the segmented egg into three distinct layers or skins. From the inner skin come the epithelial cells of the digestive tract and digestive glands. From the middle skin come the bones, cartilages, connective tissues, muscles, and blood. From the outer layer come the epithelial cells of the skin and, by a kind of embryological jugglery, the nerve cells of the central nervous system. This predestination of cell character is in reality foreshadowed at a still earlier period by territorial differentiations which make their appearance soon after the impregnation and cell division. We have, indeed, no means of knowing how early in the history of the germ plasma the future of the different cell types is definitely fixed. One thing, however, is quite clear. The governing cells of the body — the nerve cells — have their origin in materials destined to become nerve cells. Like other varieties of cells, they form a kind of caste. The democratic or essentially interchangeable feature which is found in republican forms of government is lacking here. In the animal organism those materials best fitted by nature for government find their way to the controlling power, while those materials best fitted to serve in other ways move with equal precision towards their destiny. It is thus clear

that the analogy between the animal organism and the federal form of government is incomplete and requires the recognition of the element of caste. This element secures to the organism the services of those materials best fitted by nature to fill the various requirements of life. The organism adapts itself from the beginning to the differing destinies of the varied materials stored in the egg. In fulfilling its fate, it is thus spared the losses of energy that come from human competitions which are made possible only by the failure to discern the inherent difference in powers which determine the careers of the individual citizens of a state.

I question if one can with advantage carry much farther the comparison of the living organism and the state politic. But no less a writer than Herbert Spencer tried to force the analogy. As the blood-making layer of the embryo, the mesoblast, serves for the carriage of nutriment from the inner or mucous layer to the outer layer, or epiblast, Spencer sees in this a parallel to what occurs in social progress. He says: "Between the governing and the governed there at first exists no intermediate class; and even in some societies that have reached considerable size there are scarcely any but the nobles and their kindred on the one hand, and their serfs on the other; the social structure being such that transfer of commodities takes place directly from slaves to their masters. But in societies of a higher type there grows up between these two primitive

classes another — the trading or middle class. Equally at first as now, we may see that, speaking generally, this middle class is the analogue of the middle layer in the embryo." The argument seems to me based on very dubious biology, since the bones and muscles, as well as the vascular system, have their origin in the middle layer of the embryo, and though forming a large bulk of the entire body have nothing to do with transportation. The high grade of differentiation of the muscles allies them to the governing rather than to the middle classes, if this analogy must be used here, and the bones hardly fit into the prominent distributive action assigned by Spencer to the mesoblast. Spencer also finds in the red blood cells a resemblance to money in circulation and calls attention to the fact that just as primitive societies have no money, so some lower organisms have no red blood cells. But he quite overlooks the circumstance that in modern communities business is carried on by a credit system with ever lessening requirements as to circulating money, and that for this feature of progress there appears to be no physiological analogue. Again, the comparison of the governing nervous system to the Houses of Parliament suggested by Spencer seems much too specific a limitation of the social controlling elements. The system seems rather to invite comparison with the sum of all those groups of individuals in a community that are the means of bringing order and coördination into society whilst influencing its

general course in progress. I deem it unnecessary to give further examples of what appear to me inapt analogies. It is in many cases impossible to say just where the comparison breaks sufficiently from the truth to become illegitimate. If we believe the simile drawn from organism and state to have a measure of merit, we must guard against imperiling its influence by overloading it, and we should keep our minds open to the possibility that widening intelligence is likely to compel the modification of even the most alluring biological analogies we may now cherish.

CHAPTER II

GROWTH AND REPRODUCTION

THERE are two dominant and persistent problems in biology correlated with definite functional powers which lie at the heart of human life. These are the problem of reproduction and growth, on the one hand, and the problem of consciousness, on the other. The human animal may be considered to have two sets of duties and privileges which transcend all others: those connected with the maintenance of the race through his own person, and those connected with the growth of his personality. The former duties and privileges have to do with a definite group of cells given over wholly to the function of reproduction. The latter have to do with an equally definite type of cells, the nerve cells of the nervous system, and especially the cells of the mantle or cortex of the brain and the pathways between them.

It is a highly clarifying view, and a wholly legitimate one, to regard the entire human mechanism as preëminently subserving these two sets of elementary functions — for reproduction and for the higher activities of the nervous system. And difficult as is the task of tracing the relations of these purposes to the machinery of the body, it is no

ungrateful undertaking to show how essentially subservient to these purposes are all the varied structures and devices of the human individual.

I

The cells of the body which are devoted to the purposes of reproduction form only a very small portion of the entire body, and this is true of mammals generally as well as of the males and females of the human species. Yet these germ cells hold that which forms the basis of new and complete human individuals. The substance of the male germ cell, when brought into contact with the substance of the female germ cell, or ovum, leads to a fusion of materials which not merely secures the groundwork of the embryo, but lays down in that embryo the amazing multiplicity of hereditary materials that carry recognizable family traits, physical, mental, temperamental. The painstaking studies of biologists have shown us that these hereditary qualities are subserved by an elaborate cell mechanism, which has been partially unraveled in some of its complexities, at least in so far as they have to do with structural features. The impregnated egg cell in the process of its first division into two new cells typifies the entire development of the completed human being. There within that minute compass lie the materials which predetermine with fatal exactitude the future of the adult form, its sex, its type of stature, the blending of the traits

which it owes to its parents and their parents. It is no exaggeration to say that if we could fully know the inner nature of the processes that hold sway in the dividing egg, we should hold the key to life as we see it in the adult, for the macrocosm probably has no powers that are not at least represented in the microcosm. That enzymes have a large part in determining the play of these developmental processes is all but certain. The first stimulus to the growth of the egg must be due to enzyme action. It looks as if the question of sex were settled by the enzymes with which a portion of the developmental machinery is loaded. And finally it appears as if the hereditary characters themselves were to be referred to a definite mechanism controlled by enzyme action. If we consider the mechanistic hypothesis as it bears on the transmission of hereditary characters, we find it capable of bringing a high degree of order and simplicity out of a tangle of facts which the suppositions of vitalism left in a state of confusion.

One of the most helpful illustrations of what biological science has gained from the mechanistic hypothesis is seen in the Mendelian principle or law in heredity. This law takes its name from a gifted Austrian student and monk, Gregor Mendel, who made some extremely acute and telling observations on the transmission of hereditary characters in plants. The principle which he found to hold good for plants has been found to hold good in the hered-

ity of certain animal qualities, and while it has not been shown to apply to all the phenomena of heredity, it has been a most welcome discovery to the biologist because it affords something approaching a demonstration that a perfectly definite and apparently simple machinery must underlie the transmission of hereditary characters in general. Mendel's principle cannot readily be stated in a brief definition because it involves several distinct though closely related elements. One is that hereditary characters often show a remarkable degree of independence, so that by means of crossing experiments they may be combined and recombined in many ways without permanently blending, almost as if they were represented by distinct material substances which may be put together or taken apart like the blocks of a building or the cards of a pack. It is therefore possible to study heredity accurately by concentrating the attention upon only one or a few such "unit characters." A second principle is that in respect to hereditary constitution the sexually produced organism is of double or "duplex" composition, owing to its origin from two parents (more accurately from two germ cells). A third, and the one which is the essence of "Mendel's Law," is that the germ cells are not of duplex, but of "simplex," composition. Thus, in respect to any particular character, the germ cells produced by a hybrid are not hybrid, but "pure"; *i.e.* possess the capacity to transmit but one of the two different characters

united in the hybrid. Further, when two different characters of the same general type (such as color) are united in a hybrid, one frequently conceals or "dominates" the other, though the latter reappears in the following generation. By the use of these principles it is possible to make remarkably accurate predictions of the results to be expected from any particular cross. The color of the hair in rabbits and guinea pigs, the colors of the plumage in fowls, the habit of dancing mice, are examples of separate or "unit" characters, and show the phenomena of Mendelian inheritance. An oft-instanced case of this Mendelian inheritance is that of a cross between a common gray mouse and a white or albino mouse of the same breed. The hybrid resulting from this cross does not show a blend of gray and white, as one would naturally expect. In this instance only one of the characters, namely gray, *appears* in the offspring. The other character, the white, disappears from view. By breeding these gray hybrids together both white and gray mice appear separately in the next generation. Moreover, these characters appear in a definite ratio, there being in the long run three mice that show the *dominant* character, gray, to one mouse that shows the *recessive* character, white. From a knowledge of this fundamental Mendelian ratio for a single pair of hereditary qualities, it has been possible to predict with remarkable accuracy the more complex combinations that arise when a larger number of qualities

have to be taken into account. Moreover, by means of this principle it has been possible not merely to predict the outcome of some complex combinations, but also to plan and breed new combinations successfully, much as one may sometimes foresee the nature of a new organic chemical compound that has been created by synthesis.

The Mendelian principle has already been put to use in relation to certain hereditary characters in human beings. An instructive example relates to the color of the eyes. The study of the transmission of eye coloring has been much confused by the difficulty of properly classifying the colors with respect to their purity. A feature of fundamental importance is whether the pigment lies on the back surface of the iris, as in pure blue eyes, or on both front and back surfaces, as in pure brown or black eyes, and in a less regular way in green and hazel eyes. Careful study shows that in heredity the eyes with double pigment layers dominate the eyes with single pigment layers. In terms of the Mendelian theory the pure blue (single pigment layer) eye is recessive, the pure brown (double pigment layer) is dominant. The law of Mendelian inheritance now makes it possible to explain why two parents with pure blue eyes never have a brown or black-eyed child, why the children of a pure black-eyed and a pure blue-eyed parent have black eyes, and why parents with hybrid dark eyes (with mixed pigment layers) may have blue-eyed children. If

one parent has true blue (recessive) eyes and the other hybrid brown eyes, there will be in the long run (in the offspring *en masse*, not in each individual family) an apparently definite percentage of children with blue eyes and with brown eyes.

There is some reason to believe that the peculiarities of cerebral organization that underlie insanity are subject to Mendelian heredity. On *a priori* grounds we should expect that some of the offspring of insane parents would be exempt. In cases where the offspring is implicated the nervous abnormalities may appear either in full force or in a modified form, as in a blend. In either case there may be in the next generation a complete elimination of these nervous abnormalities in some of the children. On the other hand, some of the children may show a blend inheritance which is not eliminated in the next generation.

It seems probable that we may look for the explanation of Mendelian heredity to the materials contained in the nuclei of the germ cells, for here there are found bodies which have a history in the life cycle of the organism showing a striking parallelism to the history of the "unit character," such as the gray and white mentioned in the case of the transmission of colors in mice. These bodies are well known to biologists as *chromosomes*, the clearly defined rods or loops in the nuclei of the egg and sperm seen at the time of fertilization and seen subsequently every time a cell divides in the course

of development of the egg. As these chromosomes throughout the entire life history of an individual seem to be the lineal descendants of those present in the original fertilized egg, we have only to assume that in heredity some chromosomes or some combinations of chromosomal parts stand for one set of characters, while other chromosomes or parts of chromosomes stand for different ones. This assumption, which appears entirely reasonable, gives us the simplest and clearest possible physical basis for the explanation of the Mendelian inheritance. It therefore appears that the complicated facts of heredity are growing more intelligible in the light of a mechanistic hypothesis. Is there, indeed, any other explanation which can compete with this one in probability?

Let us consider now the bearing of the mechanistic hypothesis on the extremely interesting but baffling problem of the determination of sex. Does an animal become a male and not a female, or a female and not a male, because of some obscure accident or through the operation of some definite mechanism? The researches of Professor Wilson and other biologists show in an unmistakable manner that a quite definite relation exists in some of the lower animals between sex and certain chromosomal peculiarities. The most significant evidence yet obtained can be stated in a few words. The fundamental fact is that in some insects there are two kinds of germ cells, which produce males and females respectively. In a very few cases this peculiarity

appears in the production of two kinds of eggs,— large eggs yielding females and small eggs yielding males. More usually the sexual predestination is seen not in the egg cells but in the male germ cells, or spermatozoa. The male animal possesses two kinds of spermatozoa, equal in number. One kind makes males, the other kind makes females. In this case the difference between the two kinds of sperm cells goes hand in hand with a highly remarkable difference in the nuclear substance of these cells. The sperm cells which make females have one or more chromosomes in excess of the number possessed by those sperm cells that make males. Where the female-producing sperms have one more chromosome than the male-producing sperms, the extra chromosome is a peculiar one, often visibly distinguishable from the others in size and in certain peculiarities of behavior. It is very noteworthy that, owing to this peculiarity, the body cells of the female always have one more chromosome than the male. Similarly, it has been found that where the sperms yielding females have two or three more chromosomes than the sperms yielding males, there is a corresponding excess of chromosomes in the body cells of the females.

In the phylloxerans and aphids every fertilized egg makes a female. The explanation of this extraordinary fact has been furnished by the experimental biologist Morgan. It is that in these cases the male-producing spermatozoa are rudimentary and with-

out function. But if the spermatozoa are thus inefficient in the production of males, how is the species of phylloxerans maintained? The answer is that the females reproduce without fertilization (that is, by parthenogenesis) for several generations, always, however, producing females. Ultimately the parthenogenetic females produce males. Very significantly, and consistently with what has already been said, this formation of males is attended by the loss of a chromosome from each egg destined to make a male. A similar explanation probably applies to the bees, although this has not yet been proved. These striking observations in animals have a remarkable analogy in some flowering plants. Correns has shown in cases of plants where the sexes are separate that half the pollen grains are female makers and half are male makers. These are the most obvious and vital facts at present known. There is indirect evidence which makes it probable that sex is predetermined in man and in the higher animals, as in the insects and related animals. The microscopical evidence of this is now lacking, but will doubtless be forthcoming.

These facts tend to strengthen our fatalistic beliefs. That sex is determined at the instant of conception is in itself a remarkable thing. And if this determination depends on the operation of one or more specialized chromosomes, this result is a highly significant contribution to the mechanistic basis of vital phenomena.

II

While we canot fail to recognize that it is an immense gain to biological science to know that the chromosomes may be the effective agents in the determination of sex and may give us a definite mechanistic explanation of Mendelian inheritance, yet we should not deceive ourselves as to the magnitude of the task which is still before us, or the limitations of our actual knowledge of heredity. If we ask ourselves how the chromosomes act as the carriers of hereditary qualities, we are at once confronted by grave difficulties. Let us take, for example, the problem of the inheritance of that racial memory which we call instinct. We know that as soon as a chick leaves its shell it begins to peck in search of food. This action is instinctive in the sense that it is not based on any experience of the individual chick, and has been conceived by many biologists as due to a kind of memory of the experiences of preceding generations. This memory can only be conceived as corresponding to some sort of physical traces in the protoplasm of those cells which were destined to become the nervous system of the chick, — traces established there as the result of the formation of certain habits of action in the ancestors. Now, assuming such traces to lie at the foundation of instinct (and also at the foundation of other properties connected with the

development of the organism), we are at once confronted with a question of crucial importance to biology. Are these traces derived from the transmission and accumulation of experiences (amounting to characteristics) which have happened to the ancestors, or are they derived directly from the germ plasma of the ancestors by its direct continuity and without the intervention of influences from the body cells? In other words, are we to believe that acquired characters are transmitted or not? There are two leading hypotheses on this subject that lay claim to our attention. The one which denies that acquired characters are transmitted is known as Weismann's hypothesis. The one which maintains that acquired characters are transmitted is known as the Lamarckian theory, or, in its modern form, as the mnemic or Hering-Semon hypothesis. According to the hypothesis of Weismann the racial or phyletic life of all organisms is pictured as a connected and continuous chain of germ cells. In order that the chain should continue unbroken, it is essential that the germ cells should be housed and nourished in the body, or soma, of a full-grown individual in each generation. But this body, or soma, be it noted, contributes nothing to the properties of the germ cells. The germ cells may vary spontaneously from generation to generation, but the soma in which they are sheltered is quite without influence over them in respect to inheritance. Therefore, according to this hypothesis, no characters which are

acquired by a parent can be transmitted to the offspring, and neither the brawn of the blacksmith nor the practiced brain of the thinker can benefit the child by way of inheritance. This is a contention which it is probably difficult for most persons, unversed in questions of heredity, to accept. It is a position which seems at first sight opposed to experience and probability. But if an attempt be made to give an unimpeachable example of inheritance of acquired characters, it will be found singularly unsatisfactory and unconvincing. The effects of use or disuse show no clear signs of being transmitted. The same is true of the effects of education. And if we turn to the study of mutilations, we find no encouragement there. A religious practice of the Jews has given us an example of a mutilation of singular antiquity. More than a hundred generations have been subject to circumcision, and yet no inherited influence is visible to-day. Many examples of alleged transmission have, indeed, been offered, but it seems as if none of them were good enough to be considered decisive evidence. For example, by exposing a certain variety of salamander to the action of cold, there is induced a retardation in the delivery of the salamander larvæ; and this peculiarity is observed also in these larvæ when they have matured, and in their descendants also, despite the fact that there has been no exposure to cold. But Weismann would say to such a case that the temperature which affected the original

salamanders affected also the germ plasma; and his criticism would be difficult to refute. Indeed, it is doubtful if there be a single example of supposedly somatic inheritance which cannot be equally well explained on the ground of Weismann's hypothesis.

The great strength of Weismann's position is illustrated by the well-known conditions that exist in a hive of bees. The queen in such a community is merely a mechanism for reproduction, since she is excluded from all experiences connected with the active struggle for existence. This part of life falls on the workers, who house, nourish, and protect the queen and incidentally make just those experiences which should fit them more and more efficiently for their life work. But these workers are quite sterile, and so have no chance to transmit any experience or habit they may have acquired. The queen represents the germ plasma of Weismann; the workers stand for the body or somatic cells. Any improvement in the race of bees must come from variations in the queen bees and the drones, as it is quite clear that the experiences of the workers cannot possibly be inherited. It cannot be gainsaid that the force of the Weismann hypothesis lies in its ingenious explanation of heredity, — by which a bit of germ plasma is, as it were, laid aside and held in trust to make the germ cells for the new generation. In an equally important relation, however, the hypothesis is less satisfactory. It fails, I think, to bring the process of individual develop-

ment or ontogeny into connection with definite physiological processes and is compelled to resort to a theory of determinants (or "archetectomic sprites," as Francis Darwin has aptly dubbed them) which is complicated and unconvincing. Moreover, if one believes, as many biologists do, that the somatic cells are physically continuous with the germ cells and are endowed with the same kind of reproductive qualities (as seen in the phenomenon of regeneration), the Weismann hypothesis does not give us an entirely satisfactory explanation of heredity.

Let us therefore survey briefly the mnemic hypothesis, in order to see what help it can give us. According to the German naturalist Semon (who has elaborately developed the ingenious theory designed by Hering to account for the hereditary qualities of living organisms), stimuli or irritatives of various kinds leave quite definite and permanent traces on the protoplasm of the living animal or plant. Such a trace, representing the reaction of the living protoplasm to the stimulation, he calls an *engram*. This permanent physical or chemical change in the living machine which results from the action of stimuli has been called the "internal condition," or "physiological state," by other investigators — at least there is a rough correspondence between these terms and Semon's engrams. Now the essential peculiarity of the states expressed by all these terms is the regulative influence exerted on the behavior of organisms even after the original external agencies

or stimuli cease to operate — an influence showing itself in the growth of habit. A good example of this is seen in the behavior of *Convoluta roscoffensis*, a small, wormlike animal living on the coast of Brittany and leading a life closely dependent on the tides. With ebb tide the *Convoluta* show themselves at the surface, where they form large green patches. As the flood tide covers them, they seek protection by subsidence in the sand. The effect of this rhythmical stimulation shows itself in the singular fact that when kept in an aquarium, away from all tidal action, they continue for a short period to rise and sink in the sand in time with the ebb and flow of the tide. Similar examples of habit or mnemic action are seen in plants. In sleeping plants the leaves take a distinctly different position at night from that which they take by day; they have, in fact, a habit or memory based on the alternation of night and day. But if the sleeping plant be placed in a dark room after its leaves are in the sleeping position, the leaves will take their light position despite the fact that they are screened from the stimulus of light. Here, then, we have clear illustrations of habits or memory traces which may be revived in the absence of the stimuli which originally formed these engrams, or, if not in the complete absence of these stimuli, when they are much feebler than before. Habit is, in fact, nothing more than a faculty acquired by frequent repetition of responding to a mere fraction of the original and

educative stimuli. Through the bonding together or association of many engrams it becomes possible for the higher animal to execute very complex series of actions — as, for example, when a trained musician renders an elaborate composition from memory and without taking cognizance of individual keys, — that is, with little intrusion upon the automatism established by long habit.

There is good evidence to show that the effects of external stimulation are not confined to those subtle changes, still indefinable in terms of chemical and physical processes, which are the basis of the engrams of habit, association, memory, and thought. The changes attributable to stimulation clearly extend to definite morphological changes, but we cannot yet say whether the delicate traces of memory are expressed in the more refined kinds of morphological alterations of protoplasm which are possibly recognizable by known methods of study. The degree in which the development of the individual — that is, the ontologenetic development — is controllable by the variation of external stimuli is in a high degree surprising. By altering the conditions of cultivation the color of the flower *Campanula trachelium* can be changed from blue to white and back again from white to blue, and Klebs has succeeded in bringing about the experimental formation of apetalous flowers with one instead of two rows of stamens.

Now the mnemic theory of heredity assumes that

there is a close parallelism between the processes concerned in the development of cell memory in its widest sense and the processes concerned in the development of the impregnated egg cell. This view, first clearly stated by Hering in his famous Vienna address in 1870, has been elaborated by Semon, and very recently Mr. Francis Darwin has given it ingenious if not convincing support. The growth of the individual from the germ cell is through a series of stages of cell division, the process of each stage acting as stimuli to a further unfolding, "each unit following its predecessor like the movements linked together in an habitual action performed by an animal." There is, indeed, much to be said in favor of the idea that the rhythm or progression of individual development or ontogeny is essentially a habit. This rhythm or progression certainly has the characteristic feature of habit, the automatic property visible in the execution of a series of actions in response to a mere fraction of the series of stimuli on which these actions—the successive stages of ontogeny — originally depended. But the progressions of ontogeny and habit resemble each other not merely in this fundamental quality of variability. "A habit," says Mr. Darwin, "is not irrevocably fixed, but may be altered in various ways. Parts of it may be forgotten or new links may be added to it. In ontogeny the fixity is especially observable in the earlier, the variability in the later, stages." This quality of variability is extremely

important, for on it must depend the occurrences of evolution. For, obviously enough, if the rhythm of ontogeny were firmly fixed, a species could never originate new variations, but would remain rigid and invariable.

There are two different ways in which we may think of these variations as taking place. According to Weismann, the rhythm of ontogeny can be altered only by a basic change in the very first stage of growth — in the germ cell itself. This is, indeed, the view generally held by students of biology. On the other hand, it is maintained by the upholders of the Hering-Semon hypothesis that the rhythm of ontogeny can be changed by habit, that is, by linking new engrams to old ones. Assuming that this can happen in the neural structures of an individual, and in lesser degree in other kinds of cells, how can the engrams in question influence the germ cells? This is, indeed, the crux of the whole matter. The mnemic theory holds that the germ cells share with the nerve cells the possession of engrams — engrams linked by association so that they come into play in definite succession in an automatic way, without the repetition of the original stimuli. It assumes also that these organized series of engrams in the germ cells are due in part at least to an engram action of the growing individual upon its own germ cells. Clearly this is only possible if there is some kind of connection between the nervous system and other cells and the germ plasma, a neural telegraphy,

perhaps — thus enabling the characters newly acquired in ontogeny to be transmitted and added in the form of engrams to the germ cells. In other words, the mnemic theory of development must stand or fall with the proof or disproof of somatic inheritance, or the inheritance of acquired characters.

The greatest difficulty standing in the way of the acceptance of the Hering-Semon theory is in finding evidence that the cells of the developing body or soma are telegraphically connected with the germ cells. We have already seen that there is as yet no unimpeachable evidence that acquired characters are inherited, and it must be admitted at the present time, that we have no proof of the kind of somatic germ-cell telegraphy that is demanded by the mnemic theory of inheritance. In plants there are protoplasmic threads which connect all parts of the organism; in animals the nerve fibers radiate from the nervous system to nearly every kind of cell. There is, I think, a sufficient anatomical basis for the Hering supposition that "all parts of the body are so connected that what happens in one echoes through the rest, so that from the disturbance occurring in any part some notification, faint though it may be, is conveyed to the most distant parts of the body."

Weismann looks with disfavor on the idea that germinal engrams can be formed by messages sent through nervous paths. He thinks the nervous impulses all have the same quality except in respect

to intensity, and that it is impossible for somatic changes to be transmitted telegraphically to the germ cells, to be developed later in the course of ontogeny. Such a process he cleverly compares to a telegram sent in German and arriving in Chinese. If it be true that all nervous impulses are identical in quality, this would seem a serious objection to the mnemic theory. But this is by no means proven. It is a fact that a motor nerve, like the spinal accessory, can be cross-grafted so that the impulses going through it will act in the territory of the facial nerve. When we take the case of the nerves of special sense, however, we find such great differences in the qualities of the sensations that it is simpler to admit the existence of differences in impulse quality than to find any other way out of the difficulty.

It would be useless here to enter further on the comparison of the Weismann and Hering-Semon theories of inheritance. Both have their strong points and both have their weaknesses. Weismann's theory is strong where it attempts to explain the continuity and fixity of racial or phyletic qualities, weak where it attempts to explain the rhythm of ontogenetic or individual development. The mnemic hypothesis is at its best just where the Weismann theory is weakest, that is, in furnishing a consistent explanation of the rhythm and progress of individual development. Which view will triumph in the end, it is impossible to predict. It is not unreasonable to believe that the recognition of the weak

features of these theories will lead to their being subjected to tests more carefully planned than any heretofore used, and that these tests will definitely settle one moot point after another. I feel that the evolution of the human brain and mind is much easier to explain on the mnemic than on any other, and that this hypothesis in some form is destined to be ultimately accepted. The triumph of this theory over that of Weismann would give an additional incentive to human individuals to acquire improved mental and physical characters and to avoid the acquisition of objectionable ones, since it would be felt that the offspring is certain to be in at least a slight degree influenced by these acquisitions.

The part played by natural selection in bringing about and maintaining new species or new qualities has been the subject of even more discussion than the rival theories of heredity which have just been discussed, for Charles Darwin's claims for the importance of this factor in evolution have now been before men for half a century, while the theories of Weismann and Hering-Semon are relatively youthful. There has in recent years been a tendency to minimize the importance of natural selection. That the mnemic conception of heredity operates to rehabilitate this factor in evolution is, it seems to me, evident enough. And never has the bearing of the mnemic theory on natural selection been stated more fairly or more eloquently than by Francis Darwin in closing his admirable address before the

British Association. He says: "The great engine of natural selection is taunted nowadays, as it was fifty years ago, with being merely a negative power. I venture to think that the mnemic hypothesis of evolution makes the positive value of natural selection more obvious. If evolution is a process of drilling organisms into habits, the elimination of those that cannot learn is an integral part of the process, and is no less real because it is carried out by a self-acting system. It is surely a positive gain to the harmony of the universe that the discordant strings should break. But natural selection does more than this; and just as a trainer insists on his performing dogs accommodating themselves to conditions of increasing complexity, so does natural selection pass on its pupils from one set of conditions to other and more elaborate tests, insisting that they shall endlessly repeat what they have learned and forcing them to learn something new. Natural selection attains in a blind way the ends gained by a human breeder; and by an extension of the same metaphor it may be said to have the power of a trainer — of an automatic master with endless patience and all time at his disposal."

CHAPTER III

CONSCIOUSNESS AND THE WILL

THE great French physiologist Claude Bernard, discussing the problems of life in his lucid and large way, concluded that the irreducible residuum is the power of development of the egg, to which the laws of physics and chemistry cannot be made to apply. It has just been pointed out that modern biological research has in the past quarter century gone far to show that the complicated processes of development are rooted in mechanisms that obey physical and chemical laws. The situation has in consequence changed so greatly since the days of Bernard that he would probably be among the first to admit that significant breaches have been made in "the past rampart of vitalism," as he called the evolutional forces of the egg and the cell. But there are many biologists who have looked in another direction for the irreducible residuum — to the psychical reaction, the phenomenon of consciousness. And it must be owned that in this direction but little advance has been made against what many would call the last rampart of vitalism, or indeed of spiritualism. It must be noted, too, that at this point physiologists have shown a pusillanimous spirit, for have they not

generally admitted, either tacitly or openly, that the psychical side of life is beyond the possible application of the methods of physics and chemistry? — a conclusion seemingly equivalent to the admission that there exists a non-material reality. Physiologists have shunned this supremely difficult problem, leaving it too largely in the care of metaphysicians and narrowly specialized psychologists. The true note was struck on this subject when the comparative anatomist Minot said that "Consciousness ought to be regarded as a biological phenomenon which the biologist ought to investigate in order to increase the number of verifiable data concerning it." Something of value would doubtless be won by carrying the comparative method into the psychological study of all types of life, but an even more promising way would seem to lie in neuropathology, which gives us hope that consciousness may be definitely connected with changes in the structure and properties of the nerve elements. But it is unlikely that narrow specialism will force the advances in this most subtle field of research. Rather must we look to the united labors of the chemist, the physicist, the pathologist, the psychologist, and the physiologist to penetrate this land of mystery in the hope of showing it to belong in the same category with the better-known territories of science.

Let us first state the problem so as to exhibit its main difficulties. A physical influence of some kind (as a touch on the skin), easily within reach of the

external perception of more than one person, is carried along a bundle of nerve fibers. Now at some period in this passage there occurs a fact ordinarily assumed to be of a wholly different kind, namely, a mental fact within reach of the internal perception of only one person — the sensation of having been touched. Nature gives us many examples of strange transmutations of energy, as of heat or electricity into light, or, still more striking, of the change from radium into helium. These are clear examples of the disparateness of the first and second stages of a process, but in none of these cases is the second stage of the process of a radically different order from the first. Helium, though different from radium, is like it an elementary state of matter. The phenomenon of heat and light shade insensibly into each other, and the difference between these forms of energy is apparently mainly one of wave lengths. But here, in the case before us, is an example of an apparently different order between the nerve process of the first stage and that state of consciousness which is the second stage. Where shall we find an example of an equally great difference in quality between the first and second stages of a process? Here, then, is a difficulty of a serious nature; for since we can explain the unknown only in terms of the known, we seem to be shut out from any method of approach, when we venture to deal with consciousness.

A difficulty which has stood distinctly in the way of clear thought regarding the problem of conscious-

ness has its origin in the philosophy of René Descartes. The deep insight of Descartes convinced him that matter was essentially quantitative or spatial, capable of infinite subdivision and controlled by mechanical laws. On the other hand, mind or spiritual substance was teleological, indivisible, and qualitative. Matter and mind, therefore, are realities utterly independent of each other. Matter is *nothing but* quantitative; mind, *nothing but* qualitative. This acceptance of dualism made it necessary for people to abandon any conception of a causal relation between these divided realms of the universe — matter and mind. But Descartes and his followers teach that bodily conditions, as, for example, the retinal changes under the action of light, affect the mind with perception. And just here lies the hopeless inconsistency of the Cartesian doctrine; for if changes in the matter of the retina really act on mind, how is this effect brought about if matter and mind are distinct? True causality implies a passage of energy from the causal agent to the object in which the effect arises. But how can energy be transferred from somewhere (as the retina) to nowhere (the mind)? We are forced to the view that matter and mind either do not affect each other — in which case the retinal change could not affect the mind, and God, being spiritual, could not create material objects — or there are not, in fact, two entirely independent sets of reality. There are many reasons why the mind of the biologist tends to

accept the latter view. If, however, we take the position that there are not, in fact, two entirely independent states of reality, we are at once confronted with the necessity of deciding that the basis of mind is either wholly material or wholly spiritual. But there are obvious difficulties connected with either of these assumptions. These difficulties have led to the promulgation of a doctrine which is known as psychophysical parallelism, which has its roots in the dualism of Descartes, Spinoza, and Leibnitz. According to this doctrine, each physical change in the nervous system is accompanied on the mental side by a concomitant change in the psychical system, to which we give the name consciousness. The converse is also true; that is, every mental change is accompanied by alterations in the physical state. The relation between the mental state and the bodily state is thus conceived as one of parallelism, coincidence, correspondence, or concomitance. The attractiveness of this theory lies in the fact that it does not force us to assume the existence of any causal interaction at all between mind and body. The facts of consciousness are accounted for equally well by maintaining that such causal relations as exist lie within the physical series of events or within the psychical series. W. K. Clifford stated this view with the help of the following well-known illustration: when we say "a feeling of chill made a man run," what we mean is — "the nervous disturbance which coexisted with that feeling of chill

made him run," if we want to talk about the material facts; or, "the feeling of chill produced the form of subconsciousness which coexists with the motion of legs," if we want to talk about the mental facts.

This seems a fair statement of the parallelism theory which has had so wide an acceptance. To me it appears as an entirely unsatisfactory, characterless hypothesis which contents itself to evade the real issue by word juggling. It seems to me an essentially unproductive theory, just because it seeks to evade the issue. The issue is an old one: Does brain activity account for consciousness and the powers that depend upon consciousness? I think it not difficult to show why the simplicity of this issue has been overcast and befogged by metaphysical considerations which frequently reach the point of absurdity. Some illustrations from well-known physiological processes will help us in this endeavor.

If we stimulate the nerve called the chorda tympani, there is a quick and striking response. The saliva begins to flow abundantly. Accompanying this salivary flow is a greatly increased flow of blood through the salivary gland. What is the relation of the saliva secreted to the salivary gland itself? The relation is a comparatively simple one. Under the influence of the nerve stimulus the various constituents of the saliva are made from substances already present in the gland or from the blood which flows through it. Nobody doubts that the forma-

tion of saliva is a direct and unimpeachable function of the cells of the salivary gland. No one has thought it worth while to propose that the saliva is the cause of the glandular activity; nobody has deemed it necessary to suggest a parallelism between glandular action and salivary flow, to enable philosophers to hedge as to the relationship between the saliva and the glandular action. If we stop to consider the nature of nervous stimulation and the nature of saliva, we see that they are very different things; they have the quality of "disparateness," as the metaphysicians like to say. But it makes nobody uncomfortable to believe that saliva is a result of the activity of salivary cells, and nobody takes the trouble to question the prevailing view on this subject.

If we apply a drop of acid to the skin of a decapitated frog, the animal will be seen to draw up his leg on the same side and to energetically strive to rid his skin of the acid. The act looks like a voluntary act, but obviously it is not, because the animal is headless. The apparently protective act is reflex in its nature. That is, a sensory stimulus passes from the skin along a sensory nerve into the spinal cord (by the posterior nerve roots) and by more or less devious paths, enters the ganglion cells of the anterior horns of the spinal cord. Here apparently the energy represented by the sensory stimulus suffices to unlock another kind of energy stored in the ganglion cells, and what is called a motor stimulus

is transmitted to the muscles, resulting in their contraction and the movement of the limb. The sensory stimulus carried by the sensory nerve is certainly quite unlike the motor stimulus culminating in muscle contraction. The "disparateness" of the two occurrences, sensation and contraction, is sufficiently marked. The muscle contraction, familiar as it is, belongs among the obscure phenomena of physiology; no one knows the real nature of the changes in the muscle fiber that result in shortening. Nevertheless, it has occurred to nobody to set up a doctrine of parallelism like that which is so warmly advocated in the case of consciousness. It is frankly admitted by all that contraction of the muscle is a function of the muscle and that the motor impulse awakens chemical alterations in the muscle fiber which cause the shortening we call contraction. This straightforward rational view is disturbing to nobody. Consequently we do not find eminent men maintaining that contraction and nervous impulse are concomitant phenomena or that contraction precedes nervous impulses.

It may be objected that it is not fair to liken the function of muscle contraction to the obviously more subtle one of consciousness, and that in doing so we are comparing things wholly unlike. Yet there is a feature of muscular contraction which brings it into the closest relation with consciousness. It is through the agency of the muscle sense that the nervous system is apprised of the position of the body

and thus becomes able to adapt itself to the outer world. In the case of the headless frog the organism, though devoid of the higher forms of consciousness, is still in a measure able to adapt itself to its surroundings in an apparently purposive way. This it does through the agency of muscular contractions coördinated by impulses arising from the spinal cord. Doubtless it is true that in the headless frog functional pathways exist which have been educated in the cord by the action of the brain, and that these pathways are utilized in the absence of the brain. And it would be unfair to deny that the muscular contractions give to the headless frog a property of adaptation to external conditions which if not strictly constituting consciousness, nevertheless shades gradually into states which must be admitted as states of consciousness.

When we come to consider the relation of nervous activity to consciousness, the rational view is abandoned. The rational view as to the nature of consciousness is that sensory impulses, carried into an extremely elaborate cerebral mechanism, liberate there, through chemical changes in the ganglion cells, a kind of energy which manifests itself by giving to the individual the property of awareness of self. It is likely that this quality of awareness of self (which makes intelligent action and thought possible by permitting the distinction between self and not-self) depends on the simultaneous, coördinated discharge of energy from an enormous number of

nerve cells mainly in the cerebral cortex. Indeed, I am disposed to regard the mechanism which subserves consciousness as the most elaborate of which we have any knowledge or can form any conception. Each nerve cell involved is a center of force connected by physical pathways with numberless other engines of similar type. The number and variety of these engines and the extent of their connections with each other is so large as to make possible a machine of amazing intricacy and almost unlimited dynamic possibilities. To define the limits of the mechanism on which consciousness depends is, of course, impossible. One may suspect that the energy of the dynamic discharge from the cellular elements is a factor in determining the grade of consciousness. For we have to recognize every gradation between the psychical states in which a powerful intelligence is most keenly aware of certain events transpiring within the cranium, and that state of dulled consciousness in which it is impossible to feel certain that an individual is aware of the distinction between what is self and not-self. That these variations in the distinctness of consciousness depend on the varying individuality and complexity of the cerebral elements that are temporarily associated together and on the variation in the intensity of the discharge from these elements, seems to me the most reasonable explanation of these fluctuations in the same person.

And just here we may pause a moment to ask what we really mean by the word "consciousness."

Different writers do not always use the term in the same sense, and this divergence brings confusion. I am disposed to limit the term to connote awareness of self, if any limit whatever is placed upon it. The difficulty with any definition of consciousness is that it involves drawing sharp lines which do not exist in nature. It is clear that there is a great difference as regards awareness of self between a man while eating his dinner with gusto and the same man deeply absorbed in reverie. In the latter case, he may be only vaguely aware of his personality — he is verging on the limits of consciousness according to the arbitrary restriction just suggested. A newly born child on opening its eyes for the first time has sensations, but it is very questionable if it has a sufficiently definite feeling of personality to be called awareness of self. Such a child, according to our definition, would not be conscious. Yet in the conventional sense it would not be unconscious as is a child in coma. But is it not legitimate and useful to make a fairly sharp distinction between this semiconsciousness of a child unaware of its personality as distinguished from other personalities and the mental state of full consciousness which is enjoyed by an adult engaged in physical or mental rivalry with another organized being?

If we object to limiting the term "consciousness" in some such arbitrary way to its higher expression, it is easy to see where we must land. For if the newly born child has consciousness, — that is, full

consciousness, — it is fair to say that other newly born animals have consciousness of this kind — that is to say, we must admit kittens, puppies, tadpoles, and the larvæ of insects to psychic association with man. Indeed, we cannot stop here. Not only do the lowliest animals, such as protozoa, react to stimuli, but plants and segments of plants do the same, and we shall not be able to deny consciousness to them. But even here we cannot logically stop, for we shall find ourselves recognizing as a kind of consciousness, or possible consciousness, the reactivity of lifeless organic compounds, and in succession, their inorganic constituents, the atoms themselves, and even the labile electrons of which these atoms appear to be composed. This is perhaps the sound course from the standpoint of philosophy, but it presents glaring practical difficulties. If, then, we limit the term "consciousness" to mean some higher expression of this biological function in the interest of rational discussion, why not draw the barrier at emergence of so prime a quality as the awareness of self? If we cannot feel sure that it is possible safely to weigh this quality of awareness in different animals or in some human mental states, we may at least guess it with sufficient accuracy to permit a rough classification. And this we may do without growing blind to the fact that from man's consciousness of his own personality to the reactivity of the humblest masses of protoplasm, there appears to be every gradation in the biological reactivity that

brightly or dimly mirrors the outer world on the reactive being itself.

Is it not reasonable to make the tentative hypothesis that consciousness, the basis of mind, is one of the biological functions dependent upon special and elaborate conditions of cerebral organization? This function is one that has been gradually acquired in the course of evolution as the brain has developed. Clearly it is the function which has had most to do in determining the course of organic evolution. It makes possible what living organisms would otherwise be unable to do; namely, to think or represent or symbolize. This power of thought not merely confers on man the ability to consider the impressions and stimuli of the moment, but also gives him the free use of remote experiences in the form of memory and in the form of constructive imagination. A human being thus becomes able to shape his course of action with the help of those physical records in the brain which underlie memory and make possible the forecasts of constructive imagination. It is by virtue of these relatively newly acquired functions or dynamic forces that man has distanced all other animals and the thinking man has outstripped the less thinking man.

Any hypothesis which regards consciousness and mind as a function of the brain can be criticized as begging the question, in the sense that it starts from a premise which is in dispute among metaphysicians. Such an hypothesis assumes the existence of matter

independent of mind, for it assumes that brain cells exist independently of consciousness. For this attitude of naïve realism there is the sanction of common-sense philosophy. If we refuse to take the commoner view of believing to be true what appears to be true, until we learn something which makes it appear untrue, we can make no progress in an attempt to gain some understanding of the fundamental problems of life.

The doctrine that consciousness is a function of complex associated nervous structures in exactly the same sense that the motion of a limb is a function of complex associated neuromuscular structures is naturally offensive to many persons. If mind is a function of what we call matter, it is evident that there is no necessity for turning to the supernatural to explain human feeling and emotions, however complex or noble. This belief is, of course, distasteful to the religiously trained mind, which has learned to look on the psychical life or soul as a direct expression of the existence of God, in a sense quite different from such expression of God as may be attributed to organic or inorganic nature in general. This hostility to a materialistic point of view has been a powerful incentive and influence in the fashioning of the various philosophical teachings which seek in some way to attribute mind wholly to divine nonmaterial agencies, or to admit such agencies to a dominant or indeterminate partnership in the phenomena of the soul. Other persons have been

influenced by a nearly related objection; namely, the denial of the freedom of the will, which is necessitated by the materialistic doctrine of the origin of consciousness. Huxley stated this doctrine concisely when he said: "The feeling we call volition is not the cause of a voluntary act, but the symbol of that state of the brain which is the immediate cause of that act." It is true that physiologists have no real knowledge of the nature of the chemical and physical processes that subserve the will, but this ignorance should cause us no surprise when we consider the subtlety and complexity of the cerebral processes and the short time that has elapsed since it has been possible to apply even crude scientific methods in the cause of cerebral physiology. At present, however, the questions in dispute among psychologists do not relate to the physical and chemical occurrences in the cortex. There are few who do not admit that such occurrences are in some way concerned with consciousness, will, feeling, and thought. It is the relation of the brain processes to these various psychical phases that is in dispute. According to some, the physical processes and the psychical phases are simultaneous; according to others, the psychical phases may antecede the physical processes. I do not contend that this question is one which can be solved finally at the present time, for we have always to reckon with the possibility that science will bring forward fresh facts which will make it necessary to view existing ones in a new light. But I maintain

that the rational, common-sense, pragmatic view is that the brain process precedes the psychical phase — if only by an infinitely small period — and is the cause of it. I confess also that I do not understand how any person who has studied the facts relating to education, sleep, general anæsthesia, alcoholism, general paresis, and cortical stimulation can take a different view, unless he is influenced by considerations, not scientific, but religious or metaphysical and wholly outside the limits of well-attested human experience.

If we admit that the physical processes in the brain precede and cause the various phases of psychical life, we are forced to the assumption that the human animal is a conscious automaton. The consequences of this hypothesis are far-reaching and incisive. Let us consider them in their relation to the idea of free will.

Persons who have persuaded themselves of the reality of human freedom have based their belief mainly on two considerations: first, on the fact that we are often conscious of exerting freedom of will; secondly, on the alleged implication of freedom in the moral consciousness. I think it can easily be shown that neither of these feelings is a reliable guide to truth as measured by those realistic standards whose guidance we are compelled by common sense to follow in practical life. Let us consider the case of the consciousness of free will. No one will deny that the feeling of being able to do as one pleases is

one of the most definite and satisfactory which consciousness makes possible to us. But is it on this account to be accepted at its face value? By no means. The methods used by nature in attaining certain important ends are devious and involve the use of illusions. If I ask a hungry child why he eats his food with such gusto, he will answer, "Because it tastes good." The fact that the food tastes good is, for the child, a wholly sufficient reason for eating it. The object of eating is merely a pleasurable sensation, and it is not until the child has been instructed by his elders that he vaguely feels that the object of eating is to provide material for growth and strength. Indeed, as already indicated in these pages, it has only within the last century dawned on the most cultivated minds that the body gets its energy from the combustion of food. When dissociated from appetite, the process of eating is one that inspires disgust. There is no doubt that mankind in general has been duped into maintaining itself by the belief that the object of eating is to gratify a powerful appetite. A similar illusory sensual aim surrounds the sexual appetite. When persons of opposite sex are attracted strongly to each other, the sexual element ordinarily enters into the attraction in some degree, no matter how little the subjects of the attraction are conscious of this. And when sexual intercourse occurs, it is because the participating individuals are under the sway of an imperative sensory excitation. Only rarely is the

real object of the sexual relation (the production of a child) uppermost in the minds of the parents.

The human mind is thus shrouded in illusion with respect to the two dominant instincts, for it is in general led by sensual gratification for its own sake. Even when intelligence is so developed as to give the mind insight regarding the real objects of this gratification, the satisfaction of this appetite remains the dominant motive. But if illusion is possible in respect to such vital instincts, why should it not be possible in other directions? What guarantee is there that a feeling of freedom is what it seems to be?

That argument for freedom which has its basis in a sense of moral obligation is surely not to be trusted, for this sense unsupported by the promptings of analytical intelligence is itself liable to be in high degree fallacious as a guide to conduct. How can we seriously follow the dictates of a feeling which is itself subject to reversal on the entry of new feelings or facts which may abruptly change the point of view?

But the assumption that the sense of freedom of will is illusory is not inconsistent with the view that this feeling subserves a useful purpose. Just as the appetite for food makes possible a somewhat orderly progress of nutrition, so does the sense of freedom give courage and confidence to man in the pursuit of his aims. Without the appetite for food, the nutrition of any race would be left in a precarious

state; without the sense of freedom, the constructive ideas of a race are nipped in the bud, and never reach the stage of achievement. We see this paralysis of action in just those nations which are most dominated by ideas of fatalism.

But the conviction of the reality of freedom of the will which is based on a consciousness of this freedom cannot so easily be brushed aside. If we are not, in reality, free agents, how does it happen that we feel ourselves to be such? I think the mechanistic conception of life furnishes us with at least a partial answer, based on the view that the sensation of will is a symbol accompanying or following certain physical processes in the brain which give rise to feelings or acts. According to this view, the sensation of willing is never primary or spontaneous, but always marks a reaction of the nervous system to some impulse or group of impulses originating ultimately outside the body.

Let us suppose that I enter a bookseller's shop with the intention of buying an edition of Browning's poems. The bookseller places before me two editions, alike in all respects except in the color of the binding, which in one set is red, in the other blue. I consider the two colors for a time, and, after a few moments of hesitancy, decide on the red-colored edition. In making this selection, I have not the slightest doubt as to my freedom to choose between the red and the blue — unless, indeed, I pause to think about the underlying history of my choice.

The choice as between red and blue is apparently simple, but in reality complex. It is based on three distinct factors: first, the cerebral organization at the time of birth, especially with respect to color perception and association; secondly, on the color experiences of the entire lifetime and their various associations; and, finally, on immediate cerebral experiences linked with the act of choice. As regards the state of cerebral organization, it is important to realize that at birth the cerebral material itself is not in a wholly blank and inexperienced state, but is stamped with certain hereditary memories of the species. By virtue of hereditary memories, the brain of a newborn infant may be not wholly insensible to the difference between the colors red and blue, and may, indeed, have already been impressed with traces which are the basis of a preferential reaction toward one or the other. As regards the color experiences of the entire lifetime, these may be regarded as having been laid down in strata in the receptive parts of the brain, and between these strata are interposed the stratified traces of other experiences, probably much more numerous and quite unconnected with color sensation. The vividness of the power of recollection and the nature of the association must be determined by the organization of the brain and the hereditary memories inhering in it.

These three factors cannot be dissociated, for the first determines the effectiveness and character of the

color experiences made in the second, and the third factor — namely, those experiences immediately connected with the act of choice — operates upon a substratum provided by the first and second factors. The third factor must be regarded as relatively insignificant to the second one. In an experienced person, it is the last link in a long chain of color experiences. Its importance lies in the fact that it seems to be the cause of the choice, while in reality it is the obtrusive determinant and only a small element of the essential cause. The antecedent color impressions may, in their entirety, have been a thousand times as prolonged or intense as the final one which apparently effected the choice. Yet these many impressions are not singly remembered, but, if recalled at all, are fused into a vague and indefinable memory in such a way as not consciously to enter into my choice. Yet despite this apparent unobtrusiveness, it is this past experience in its entirety which is the actual basis of my choice — the act of choice being merely an elaborate automatic reaction in which the colors before me act as excitants.

I feel my choice to be free because I am conscious of a desire to reach a conclusion and of satisfaction in having reached it. But I quite fail to recognize (without deliberate and unwonted analytical effort) the real, underlying cause of my choice. When I come to reflect on the entire history of this little option in color, I am unable to convince myself that I have been in reality free at any point in the pro-

cess. It seems to me that I have been free only in the sense that I have had the feeling of freedom, and when I examine this feeling it vanishes without leaving a definable or satisfactory residuum. In choosing red rather than blue, I am left with the feeling that I might have chosen blue rather than red, provided, of course, that I do not deliberately subject the process to psychological scrutiny. Yet I am compelled to think this feeling quite illusory, however gratifying it may be to my self-confidence and self-esteem. For it is clear to me that my choice of red as against blue was as definitely fixed and predetermined in the refined physical mechanisms of my brain, as is the sex of a child at the instant of union of the sperm head with the nucleus of the ovum. Just as the sex of the child does not become apparent until some time after the fatal impregnation, so the choice of a man may not become apparent until long after all its essential elements have been fixed. No methods of science now at command can enable us to say surely whether a newly impregnated human egg is destined for male or female, despite the fact that the data of experimental biology have rendered it a practical certainty that the sex is in reality fixed. And where a human choice depends on nicely balanced factors, we cannot predict how that choice will be made. Yet it seems to me that the factors in every choice are fatally predetermined and that only our ignorance of underlying conditions makes an accurate prediction impossible. Spinoza

epigrammatically expressed this view when he said: "Our feeling of free will is but ignorance of the causes that make us act."

This is frankly fatalistic doctrine, but it need not be either blind or depressing. On the contrary, I believe a scientific fatalism to be both enlightening and encouraging to serious natures. If it brings sobering influences into life, which in some degree dissipate the cloud effect of Yoganidra, it carries compensations in the form of increased efficiency, greater understanding, and, above all, greater tolerance of the faults and sins of the human race. It is worth while to consider briefly the doctrine of scientific fatalism in some of its relations to our individual conduct and to the conduct of other people.

When an educated individual of mature years looks back on his career, it is inconceivable that he should not recall many thoughts and acts which he would wish to have been otherwise. According to his temperament and training, he will regard the mistakes of the past with the equanimity of the man of affairs who has learned to lose no energy in vain regrets, or will suffer periods of depression from disgust with the failure to attain a higher level of thought and action. There exists always the possibility that a philosophical attitude cognizant of the fatalistic elements that underlie and govern every life will aid in reaching such higher levels in future experience. The elements which demand recognition are those which have been already mentioned.

First, there is the organization of the nervous system. This must be regarded as absolutely personal or specific for each human individual. If we knew enough about the make-up of human brains, we could probably distinguish many types of organization, but while those organs falling within each type would resemble each other closely, each brain would, nevertheless, possess distinctive features. One is prone to think of the newly born child as lacking in the physical traces of experience; and there is one sort of experience of which the brain of the newly born child is apparently destitute. The phenomena of instinct have their probable explanation in the records or latent memories of race experiences, which, in the helpful hypothesis of Semon, are known as the mneme. When a newborn infant grasps a bar with its toes in simian fashion, it does so in response to the awakening of this racial memory. The respective centers have thus been written upon by impressions carried in the germ plasm.

Now if any fact emerges with clearness, it is that the individual human being is answerable neither for his nervous organization nor for the imprints or engrams which have sunk into that organization. These are things which he must accept as he accepts the weather—not necessarily with approval, but with acquiescence. The second element which molds his life history and personality is made up of the massed experiences of his career, which have reacted with the organization of the brain in such a

way as to secure a definite yet plastic product. Here again there can be no question of responsibility until there have been awakened those symbols of a certain kind of cerebral action which we call will. Let us suppose that the will is weak, that is to say, offers little resistance to sensual enticements, even when these are vaguely or clearly recognized to lead to undesirable results. This weakness of inhibition has its basis in the organization of the brain, but cannot be wholly referred to it because it is a product in which the sum of all experiences (or training) is also a factor. Given a cerebral organization of doubtful stability (or in the somewhat inadequate language of physiology, an organization characterized by lower cerebral and spinal reflexes disproportionately active in comparison with the inhibitory mechanism of the cortical portion of the brain), the outcome in the form of conduct must depend mainly on the character of the external influences that have come into operation. If these are of an enlightening kind, they will have opposed an obstacle to thoughtless acts based on elaborate reflexes, or will have moderated the disposition to more deliberate acts which accord badly with the best dictates of experience. If, on the contrary, the external influences have not awakened the intelligence and good feeling necessary to hold in check those complex reflexes which dispose to hurtful action, there will result what we call mistaken or bad conduct. If an inviting alcoholic drink is set before me when I am

thirsty, it will intensify in me the desire to slake my thirst. The sensation is a quite normal one, but it does not follow that it is best for me to respond to it by taking the drink. Experience may have shown me that the indulgence in drinks of this kind is liable to be followed by undesirable consequences. If, knowing of these consequences, I yield to the temptation that has presented itself, I am acting in opposition to a normal instinct of self-preservation, and if this instinct is repeatedly defied, the error in conduct may ultimately jeopardize my life and so tend to eliminate an individual possessing a defective nervous system. For this hurtful conduct clearly has its origin in a nervous system defective in the sense that it shows a want of balance between the reflexes subserving appetite and the higher mechanisms of control. I cannot feel that blame should attach to defects of this kind, or to the uncontrolled acts which come from them. They seem rather the proper objects of pity and help. By help I mean all rational restraining and controlling influences brought to bear from outside. The fact that a human nervous system has repeatedly given evidence of lack of stability in one or more directions does not necessarily show that under favorable environment a better balance may not be established between the reflexes subserving appetite and the higher mechanisms of inhibition located in the cerebral cortex. But to establish this improved balance, it is evident that we must look for outside

help, since the unstable nervous system we are considering has shown itself incapable of gaining this balance by wholly spontaneous reactions. Almost any person who recognizes that his conduct has been characterized by habitual lack of inhibition in one direction or another will realize also that the desired balance might have been attained had he been so fortunate as to be subjected to insistent corrective human influences from outside. Such a belief is justified by the facts of experience. In other words, there exist powerful educational corrective forces which may be utilized for the benefit of the very many nervous systems which need such outside help to aid them in establishing that balance between lower and higher centers which is necessary to minimize the great losses of human energy and efficiency which are the expression of the failure to attain such a balance. Perhaps the greatest need of the human race is an enormous increase in the forces of education which may be applied by superior and balanced nervous systems to those in which there exists a want of proportion between the reflexes subserving fundamental appetites and those inhibiting centers which are their physiological guardians. The individual who has come to realize the automatic character of his own acts and the fatalism which surrounds them will learn not to waste time and regrets for his mistakes, but will bend his energies to the avoidance of mistakes of the same sort, and he will do this because the stimuli of experience set

in motion elaborate cerebral reactions which have their basis in the organization of the brain. The automatic mechanism which thus reacts not merely to stimuli arising within the organism, but also to many stimuli from outside, is a mechanism of extreme complexity, delicacy, and plasticity. But I cannot see that these qualities which make possible a great variety of emotions and feelings and acts, following each other in rapid and uninterrupted succession, give any evidence of a freedom of action or of ultra-mechanistic forces. In the period of vigorous growth and increasing powers, it is difficult for people to believe themselves to be essentially automata, for it is not at once obvious that the various increasingly complicated acts and achievements of life are simply expressions of growing complexity in the machinery of the nervous system which thus becomes able to support more and more elaborate reactions. But in the period of declining powers, of failing memory, or of more and more restricted ideas, the skeleton of mechanism becomes more obtrusively apparent, and the atrophy of the brain engine gives the undeniable clew to this simplification in automatism.

The recognition of the fatalistic and automatic nature of the acts of other people must follow on its detection in one's own life. A scientific fatalistic personal creed must, therefore, powerfully influence the judgments formed on the conduct of other persons. The better understanding of the causes of conduct in others must necessarily cultivate in us a

greater leniency towards acts not in accord with our own views. Such acts we shall learn to refer with some confidence to the various factors which find expression in them. The fixed elements in these acts we shall learn to accept, but at the same time we shall recognize the possibility of preventing their recurrence by means of legitimate interference. The use of adequate and temperate correctives in place of vindictive and revengeful methods of punishment should be a result of a better insight into the causes of undesirable conduct. The attitude of parents toward children and of society toward criminals could be greatly improved by enlightened biological and philosophical training. The noteworthy change in feeling in relation to the insane is a good example of what can be accomplished through the growth of a humane scientific conception.

A position of enlightened and scientific fatalism which takes account of the wonderful plasticity of the brain in respect to reactions and impressions or engrams must ultimately soften the over-rigid ideas of right and wrong which still prevail. The human automaton is dominated by two fundamental instincts—the self-preservative and the sexual. There are few persons whose instincts in these directions do not require to be regulated and inhibited at some period of their lives. In our age, a very large proportion of all the miseries of life and nearly all the crimes are traceable to perversions of one or both of these instincts, which continually crop out

in excessive egotism and sensuality. The world is not very intelligent in its way of looking at these outbreaks. There have gradually emerged conventional standards of behavior which leave much to be desired in regard to ideas of what is good and what is bad. These grossly imperfect and inconsistent standards are due to a delay or failure in appreciating the biological causes of conduct. Conduct is the expression through the muscular system of desires, feelings, and emotions which are functions of the nervous system. The human nervous system, notwithstanding its great complexity, must be regarded as exemplifying the same forces and laws of nature as less complex and less highly organized aggregations of matter. But we cannot attribute to nature either goodness or badness. Nature is neither good nor bad, neither right nor wrong, neither kind nor cruel. She is simply consistent. Yet the consistency of nature is not always simple and obvious, for the reason that her happenings are often the result of conflicting forces. When we speak of human conduct as good or bad, right or wrong, kind or cruel, we simply mean that larger or smaller groups of human beings in the course of their culture have come to designate or describe various acts, of which they approve or disapprove, by means of these terms, associating them sometimes with rather well-defined conceptions, at other times with more vague ideas. These conventional conceptions, reflecting as they do the composite yet

somewhat plastic verdicts of mankind, deserve a respectful attention. Generally, perhaps, they contain at least the germ of justice, yet judged from the biological standpoint these verdicts are liable to be erroneous and unintelligent. The different ideas of right and wrong that are prevalent among different peoples, supposedly civilized, attest the lack of uniformity which prevails in the judgment of human conduct. It is of the utmost importance for the establishment of humane and enlightened standards of judgment that we should realize the fallacious nature of all attempts to set rigid definitions to the words "right" and "wrong." To imagine that these words connote fundamental differences in conduct is a mistake which has had many unfortunate consequences, owing to the facility with which disapproval leads to harsh punishments. A girl who kills her illegitimate child because hypercritical social ostracism has brought profound discouragement to her is severely punished for the act by the same society which has been an active factor in determining her act. From the standpoint of the conventional judge, her act is one of the blackest of crimes, while from a scientific standpoint, it was merely the natural automatic response to an intolerable state of affairs for which the unfeeling attitude of society was largely answerable. It might help somewhat if people should agree to call those acts good which, on the whole, appear to be in accordance with natural laws and in the direction of promoting

the best human ideas based on the recognition of biological laws. But even a scientific standard would be difficult to apply on account of the intricacy of the situation which frequently comes to notice. A man may commit many acts opposed to nature, and therefore bad in their character, yet his helpfulness to human interests at large may be so great as to more than offset the acts we call bad, and so leave in his favor a balance of what we call goodness. But if it cannot be maintained that the mechanistic view of life can at present give us more than a clew to the ways of reaching more reasonable conceptions and appraisals of human conduct, one great and useful service may be claimed for it. By showing us at once the extreme complexity of the biological factors that determine conduct and our ignorance of the many phases of these processes, it shows us the futility and injustice of forming hasty judgments on the behavior of the human beings whom the illusory chances of life bring within our acquaintance. At the same time it extends a reasonable hope that much more intelligent and humane appraisals of conduct will follow the extension of a biological point of view among the masses of the people. Pope's oft-quoted saying, "The proper study of mankind is man," makes a good general statement of the leading aim of human striving. But if the study of man is to bear fruit in gentle and sympathetic relations between human beings, that study must seek a broad basis in those sciences which

give increasing insight into the mechanisms governing human character.

Thus the mechanistic view of human life and the scientific fatalism with which it is interwoven do not lead to hopeless resignation. They do not mean an abandonment of desires and interests in favor of a Hindu-like contemplation of the navel. On the contrary, they point unmistakably toward the utilization of the great potential forces that exist in nearly every normal individual. It has probably never happened that a human brain has been educated or developed to anything like its real capacity; nor is it likely that such a development will ever take place. But ordinarily the results do not merely fail to approach the ideal, but fall pitifully below it. A locomotive which fails to develop more than a small fraction of its potential capacity would be regarded as a failure and would quickly be replaced by one of a better type. Probably most human nervous systems develop only a small fraction of what is within their power, either quantitatively or qualitatively. The recognition of this will lead to increasingly intelligent efforts in the development of personality, — in other words, to improved education. Scientific fatalism recognizes not merely the inherent limitations of the human mechanism (which depend upon the quality and inherited memories of its protoplasm), but also the nearly limitless possibilities of reaction in a machine so labile and receptively capacious as the nervous system. To develop

most efficiently the reactions that are inherently possible outside help is needed, the help derivable from contacts with nature, from books, and especially from the experience, example, and advice of other human beings. Such help makes possible a nearer approach to individualistic development. But just in so far as this development of an individual has been facilitated by the help of other people, there is created an obligation, in the person so aided, to give help to those who require it under conditions that do not endanger personal efficiency and the possibility of further individual progress. This interchange of help is, and must always remain, an essential feature of civilization, but it can reach a high degree of efficiency only where the utmost encouragement is given to the most enlightened interests of the individual. The doctrine of scientific fatalism thus takes account of the great possibilities of the individual and of the race. It teaches that each human being should have the best obtainable chance for self-development, and becomes the enemy of social conditions which stand in the way of such opportunity. It teaches that an individual should be judged in relation to the chance he has had for self-improvement, and not by any arbitrary standard. But it does not teach that any two human beings are equal in potential for achievement. It expects many failures, but it judges them leniently. It counts on the emergence from time to time of human beings able to point out new

relationships between old materials; yet it does not overpraise these successes. It looks hopefully to the future because it sees in the human germ plasm a tendency to improve in the presence of reasonably friendly surroundings. It is the enemy of the doctrine of *laissez faire*, believing in intelligent interference and regulation in all directions. It recognizes the dangers of incompetent interference, but knows that progress can be made only by taking some risks in experimentation. It recognizes that there are limits to the utility of interference in human affairs, but teaches that these can be found only by trial. And finally, the doctrine of scientific fatalism looks only for results exactly proportioned to the factors which determine personality — the forces inherent in the germ plasm and the external forces which have been brought into action upon these primitive materials.

BOOK II. THE SELF-PRESERVATIVE INSTINCT

CHAPTER IV

THE INSTINCT OF SURVIVAL

The instinct of survival or of self-preservation is, in general, the controlling animal instinct, notwithstanding that its outward expressions may be temporarily checked by the intrusion of other fundamental and highly organized feelings or impulses. The instinct most likely to intrude on the survival instinct is the instinct of sex, which stands in the same relation to the preservation of the race as does the survival instinct to the preservation of the individual. And in man, other instincts of dignity or importance, as that of imitation, of curiosity, or of sympathy, may for a time supplant the outward signs of the survival instinct, although it is clear that these reactions are functions of relatively recent origin growing out of the more fundamental ones.

It has been already pointed out that the various cells of the animal organism are endowed with distinct and elaborate powers of defense, powers on which the maintenance of the life of the individual is closely dependent. Since these powers reside in the organization of the cells, expressing mainly their

inherited physical and chemical properties, they may be regarded as the basis of the instinct of survival or self-preservation. But when we ordinarily talk of the instinct of self-preservation, we do not picture in our minds these defensive powers of the cell. We mean rather these qualities of the individual as a whole which enable him, and seem to constrain him, to look out for his own interests as opposed to the similar interests of other individuals. We have in mind acts of offense and defense connected especially with personal maintenance, based on reactions of the nervous mechanism.

Is there not, in reality, a close connection between these self-protective reactions of the nervous system and the defensive powers or survival instincts of the non-nervous cells of the body? Nearly every kind of fixed cell in the body receives nervous filaments directly or indirectly connecting it with the central nervous mechanism. I see nothing improbable in the view that the receiving centers, including the sentient apparatus of the nervous system, are kept telegraphically informed in regard to the multiple needs of the cells with which they are in mechanical connection. And if this be true, I see no serious objection to the view that the nervous system, as a whole, reflects the combined survival instincts of the cells which it serves. On the contrary, it seems that such a view could be successfully defended in respect to many details implicated in its acceptance. It has already been pointed out that the cellular

elements of the nervous system itself are endowed with only a very limited capacity for defense — that the survival powers of nervous tissues are small as compared with those of glandular organs. There thus appears a well-defined differentiation of the organism in relation to the self-preservative instinct in general, the nervous system expressing in its manifold adjustments not merely the reactions of adaptation to the outer world, but also the adaptations especially demanded by the active cells of the body. The instinct in its narrow sense may be said to reside especially in the nearly defenseless nervous system, whereas the ultimate powers of defense — which we are assuming to be the basis of the survival instinct — lie chiefly in the glandular cells, inexpressive, and relatively insentient in the ordinary meaning of these words. And I think that we are safe in believing that just as the general body cells with their rich endowment of survival powers find in the nervous system their agent for instinctive demonstrations, so the sexual cells with their reproductive powers find an expressional outlet through the nervous system in those feelings and acts—antithetical in many ways to the personal survival instincts — which we interpret as the sexual instinct.

The most fundamental expression of the self-preservative instinct is the appetite for food, an admirable example of a nervous expression of the needs of the body or somatic cells. We must comment on some of the effects of this appetite.

The output of energy from the body machinery is attended by a loss of material substance, and this loss is continuous, even when that machinery is in, what we call, the resting state, as in sleep, where the voluntary muscles and mind are quiet. The output of energy lasts as long as the spark of life is unextinguished, because just so long must the production of animal heat continue. If there are no new sources of energy from food, the outflow of energy is at the expense of materials which are stored, such as glycogen and fat, and to a lesser extent the living protoplasm itself. The need for new supplies of combustible material is associated with nervous impulses passing from the glandular cells of the digestive organs to the central nervous system and rising into consciousness as hunger. If by some drug the appetite for food should be abolished, the life of the organism would soon come to an end, and during the period of starvation the body would live on its own tissues, with a restricted output of energy. So completely does self-preservation depend on the appetite which respects the needs of the body cells — the somatic appetite as we have called it to distinguish it from the sexual.

I

The hunger for food constitutes the chief occasion for releasing that energy of performance which we call the power of the will; for, until appetite is

gratified, man, like lower animals, has a powerful incentive to search actively for nutriment and to defend his real or fancied rights to it by active hostility to competitors. A real advantage arising from this enforced search for food is that the effort spent in getting it helps to maintain physical vigor. So soon as man develops sufficient imagination to strive, not merely for his immediate needs, but also to forestall his future ones, by accumulating a food supply, whether by killing game or by cultivating the land, he becomes a capitalist. This introduces an entirely new element into his life, and one which operates not wholly to his advantage. To be able to eat as much and as often as one wills and, as in modern life, to have food so served as to overstimulate the palate, leads inevitably to excess in food and to undue prominence of the pleasures of the table in the general scheme of life. The effects of gormandizing are seen at all ages from the period of infancy, when the mother overfeeds her child in the belief that the more abundant the food, the better the development, to the strivings of senility to build up the system by tempting the appetite. It is not simple to define the physical evils that follow excessive feeding mainly because, aside from obvious derangements of digestion, these evils are partly due to associated errors in living, such as excessive work and undue emotional indulgence associated with indoor life. But it is no exaggeration to say that man suffers from this excess many ills that entail

a loss of energy to the organism and a deterioration of temper and character, and probably (in association with nervous influences) a state of premature senility. The remedy for this waste of human power is to be found only in methods of education which develop in the inhibitory cortical centers of the brain the needful self-control, and which teach the rational use of food as a source of energy and discourage the overdevelopment of the element of self-gratification.

The capitalism which shows itself in the accumulation of food stores early exhibits itself in efforts at housing man and the fruits of his industry. This leads in time to the substitution of indoor life for outdoor life in a considerable measure. Two important consequences come in the train of this progress which must be charged to the debit side of the account. First, a loss of interest in nature and the resultant decadence of a valuable kind of inspiration and knowledge; and second, a reduction in outdoor life and exercise which favors a decline in physical health and which shows itself (especially in overheated houses) in a greater susceptibility to many kinds of infections, and to overdevelopment of the emotional and sensual side of the character. An unexpected result of excessive indoor life in modern communities is a greater susceptibility to tuberculosis, and it is highly suggestive to note the certainly emergent fact that the best treatment of this disease involves outdoor life by day and by night;

that is, a return to primitive conditions. Moreover, it is becoming each day more and more clear that many other physical disorders are best treated in this manner; and so strongly is this idea gaining ground that modern hospitals are providing themselves with facilities for giving many of their patients the opportunity of living out of doors the greater part of the time, in summer and winter, by day and by night.

The accumulation of food supplies in response to the undeniable stimuli of appetite brings satisfaction to man in various ways. First, it supplies the source of free gratification of appetite for the individual himself, and for those who are most nearly related to him. Secondly, it leads to an increase in his personal importance in the community, which is gratifying to that form of self-consciousness that derives pleasure from the sense of recognition of one's powers; that is, what we call vanity. Moreover, the actual increase of personal power and influence is one of the most intelligible effects of this primitive form of capitalism. Finally, there is a distinctively pleasurable sensation which, in some degree at least, arises not only in primitive, but in modern, men from the sense of exclusive ownership; that is, the pleasure that comes from being arbitrarily able to influence the actions of others, through the ability to exclude them from that which has been appropriated. This is a very deep-seated feeling — an outgrowth of the instinct

of self-preservation, and may be greatly exaggerated under some conditions so as to show itself in the hoarding of the miser and in other manifestations that depend on overattention to that which has been acquired. This sense of personal proprietorship is by no means confined to the sphere of material things, but is witnessed in the world of learning, where the greatest jealousy may be shown in regard to discoveries or priority in inventions, even where these cannot be the direct source of material advantage except in the sense of heightening general prestige.

That the effects of capitalization are in general very distinctly advantageous to man is so obvious a truth as to require no discussion, whatever may be said against the abuses of the modern capitalistic system. In fact, it may be successfully argued that the employment of capital — that is, accumulated energy — is an essential tool of human progress, rendering possible an economic development which permits a rapid growth of population under conditions of increasing physical comfort. Still more important, but inseparable from this material progress, is that individual leisure which is the most precious fruit of capitalism. The intelligent use of this leisure facilitates the higher kinds of thought and so aids in the establishment of better ideals of life. But while capital is an instrument for the elevation of some, it is the undoing of others. For, like all other forms of stored energy, capital may

be destructive as well as constructive. In the hands of the ignorant and the undisciplined, it is more likely to prove injurious than helpful. The reason for this is plain. The unrestrained and sensual man is unable to control the energy which can be liberated from capital. He permits it to be released in currents that run counter to the preservation of that which is best in him. The result is exactly comparable to that which comes from the reckless use of dynamite, with the single difference that here the destructive consequences of the uncontrolled liberation of energy are sudden and obtrusive, instead of gradual and interwoven with other injurious influences.

One of the most noteworthy features of elementary instincts is their definite tendency to exaggeration. The instinctive reactions to stimuli are seldom at first nicely proportioned to the stimuli which invite these reactions, but are, in general, excessive. This tendency obtrudes itself both in the self-preservative instinct and in the instinct of sex. The exaggerations of the self-preservative instinct are the basis of a large part of the miseries of human life. They appear before us in daily life in many guises, but mainly as the intemperate eagerness to gain recognition and power in one form or another — an eagerness finding expression in greed, cruelty, and deceit. It is clearly observable that in the struggle for wealth men seldom stop at the points of gain which would satisfy reasonable needs. So, also, in a phys-

ical struggle with an adversary there is a strong impulse to do more injury than is necessary for mere self-protection and preservation. The same tendency to overaction is recognized in the vulgar inclination to "hit a man when he is down." As might be expected, these self-preservative exaggerations are seen with especial distinctness among the lower animals, where contests commonly lead to the death of the weaker organism. This is, of course, true of primitive man and, in general, of man engaged in war, but intelligence — the expression of memory and imagination — powerfully mitigates this overaction. And it will continue to do so, increasingly, as the human animal grows in experience.

From a biological standpoint, these overactions of the nervous system in the interest of self-preservation have a deep interest. For, if we revert once again to the defensive or self-preservative reactions of the cells, we find in them a tendency to overact on stimulation — a tendency which strongly suggests a basis analogous to that which is so markedly exhibited by the nervous system as a whole. If, with a sharp, thin knife, we make a clean cut into the liver of a living animal, we find that the wound is promptly repaired. But it is a notable thing that the cells which react to repair this wound are not merely those which have been injured by the knife. The reaction of repair is discernible at a measurable distance from the damaged cells in structures apparently not

directly affected by the incision. There is, in other words, a reparative reaction out of proportion to the obvious necessities of the case. The same tendency is shown by the cell reactions which follow the injection of certain bacterial toxins into the living body. The antitoxin produced is by no means accurately proportioned to the immediate and obvious needs of the body, but is far in excess of these.

Without forcing the analogy, may we not assume that there is an essential likeness in these excessive cell reactions to the injuries and the overactions of the nervous system as a whole, which are evoked by hostile stimuli (or stimuli interpreted as such) coming through the pathways of the special senses? And does not such an interpretation somewhat aid us in our conception of the real self-preservative nature of many human acts which are repellent to our more experienced natures? Since the self-preservative reactions of the nervous system are in the highest degree automatic and reflect the action of centers controllable by higher ones, the individual and the race has before it the possibility of bringing these centers which voice the self-preservative instincts under better and better control.

These considerations bring us, in fact, to the most significant of all human questions — How far is it possible to control the self-preservative instincts in the interests of the race as a whole, without imperiling the legitimate and essential interests of the

individual? This question, which is obviously inclusive of the destiny of human society, is undeniably a biological one. In a limited sense, it is a problem in cerebral physiology, for it means nothing more nor less than the possible degree of subjugation of the lower cerebral centers to the highest controlling and inhibiting ones. It is quite clear that the human individual, to attain to his noblest expressions, must, in general, remain an efficient animal, and that he must feed, clothe, and shelter himself accordingly. It may perhaps also be successfully contended that the luxury of æsthetic influences cannot be omitted. But it is doubtful if the elaborate luxuries of modern civilization are really essential to the best individual preservation. These questions can be answered only as the result of long and painful human experiences. And we should doubtless be right in regarding most of the pitiful sufferings of humanity as necessary incidents in the working out of the great human experiment into whose resistless currents we have been born, that we may contribute something, though in large degree unconsciously, toward the establishment of a better equilibrium than now exists, between the instinctive and controlling forces belonging to living protoplasm.

II

If one thinks of the instinct of self-preservation as it shows itself at different periods in the development

of human individuals, it is clear that there are distinctive peculiarities in the expression of this instinct at different ages which exhibit a definite dependence on the biological attributes. The helplessness and vague consciousness of infancy is succeeded by the improved attentiveness and better motor control of childhood with its seemingly inexhaustible supply of reserve nervous energy. The rapid growth of infancy and childhood, like the still more rapid growth that occurs in the womb, depends upon an extremely abundant supply of nutriment — in the former case as food, in the latter, from the mother's blood. The rate of growth, both of body and brain, is somewhat less during adolescence and early adult life, when the growth of the sexual glands intrudes upon the physiological processes in such a manner as to stir consciousness with sexual feeling and thus heighten a growing self-consciousness which is liable to express itself through overconfidence and other manifestations of crass egotism. In early adult life, the elements of character are well determined, yet sufficiently plastic to be significantly molded by the forces of education. The struggle for a living is intense at this period, for the average man, and makes him view his rivals and opponents with suspicion, and the eagerness to succeed too often causes him to deal harshly and inconsiderately with those who stand in his way. Physical vigor is now at its height, and the capacity for sustained mental and physical exertion is notably great. This early adult

period is the time for performance and for the assumption of necessary physical risks. And this is also the time for reproduction. In middle life, physical vigor begins to decline, although the body tends to accumulate reserves of energy which show themselves in a disposition to obesity, where nutrition is good. Judgment receives the benefit of the increment due it from long experience. Well-founded self-confidence tends to mitigate aggressiveness and to allay suspicion of others, while the mellowing process is still further accelerated by a recognition and acceptance of personal limitations and by the perception that the margin of life's expectation is no longer a broad one. The value of life is, in this period, the greatest of all, for it is the time of that conservative and ripe judgment unmixed with timorousness, which is so needed to correct the impulsive and erroneous tendencies of youth and to encourage and reënforce its true ones. The decline of sexual passion directs life processes more and more into somatic and intellectual channels, without depriving the individual of the humanizing experiences of past sexual life experiences. The period of senility is one of accelerated wasting of the body and relatively slow failure of the mental processes. The reason for the divergence in the rate of decay of body and mind probably lies in some definite physical characteristic of the brain. This immunity of the brain substance to the effects of retrogressive metabolism is only a relative one, and memory,

ideation, and emotional life gradually decline despite of it. These alterations in the spiritual sphere are attributable to a slow atrophy of the brain, particularly of the cellular elements of the cortex. There is, in general, a decadence in character, although this may be so slight in degree as to escape the notice of indulgent companions. Perhaps the main evidence of this is a certain loss in sympathy and considerateness for others which is a part of the growing callousness. The change is, in some respects, like that which is witnessed in the wasting of the cortical substance in the disease known as general paresis, though much slighter in degree.

III

If life be worth living, it is logical to yield to the instinct to prolong it, so long, at least, as any satisfaction can be got from it or given by it. And, giving way to this instinct, people have, for centuries, striven to increase the number of their days, sometimes by rational methods, too often by resort to unintelligent measures, unfounded either in reliable empiricism or in correct theory. It may justly be claimed for modern medical science that it has gone far to show mankind what it may expect in promise of life, and on what sources its expectations must be based. The last word has certainly not been uttered on this subject, but the possibilities can, with some confidence, be defined. It is true

that the conditions of modern life in civilized countries do not give the best opportunity to test the question of the maximal limits of life. The sedentary habits and the competitions incident to such life stand in the way of anything like a fair test. For this reason, it would well repay the government of any great nation, as, for instance, the United States, to inaugurate a well-planned and extensive experiment in longevity by placing a group of selected persons under conditions that would permit the utmost prolongation of the machinery of life. Such a trial I regard as practicable and capable of yielding results of such value as would more than compensate the expense to which the nation would be put. The long trial would end in establishing a standard of attainable longevity under ideal conditions. The value of such a standard would lie in the fact that every individual would see before him the possible results of life under favorable conditions, and many members of the community would certainly have sufficient intelligence to strive to secure these conditions. For as men grow more thoughtful, they prize increasingly the mental life, and desire to prolong that period of life in which the spiritual experiences are dominant. At present the conditions of ordinary life are not, in general, ideally favorable to the prolongation of life, but it cannot be doubted that a large body of citizens, united in the serious wish to favor social changes looking directly and indirectly to the lengthening

of life, would have a potent influence in compelling the important changes which education and legislation could effect.

If science has not yet formally given us the final rules for attaining the utmost longevity, she has made clear one guiding principle. It is that we cannot hope for any specific recipe for long life, but rather that the prolongation of our days is to be reached through the evasion of that multiplicity of hurtful influences which, taken together, impair the bodily machinery in sufficient degree to rob man of some portion of the life that was possible to him in view of the potentiality inherent in his organization. According to this view, the lengthening of life in general must be attained through a wide knowledge of physiological processes, and through an intelligent application of this to the needs of each individual.

It seems worth while to consider the injurious influences that curtail human life, since the control of them is the key, not merely to longevity, but also to greater efficiency and greater happiness, through the prevention of disease. And in any discussion of the prolongation of life, the consideration of the theme of maintenance of health, physical and mental, is quite unavoidable.

It has long been customary to make a sharp distinction between the things that injure the body and those that injure the mind, and this separation is still serviceable, notwithstanding the fact that

there is a large territory where the material and the psychical overlap. We may consider first the injurious agents that affect the body, and then those that affect the mind.

Damage to the body mechanism may arise in many ways. It may occur very early in the life of the individual,—in fact, previous to birth. Disease in father or mother may act so injuriously on the germ plasm as to affect the embryo in a hurtful manner, and mortgage its future; and a similar result may follow from acute or chronic poisoning of the germ plasm of either parent. These congenital influences are capable of showing themselves in many ways,—in malformations, gross defects, tumors (including cancer), and in a predisposition to diseases such as gout, diabetes, epilepsy, insanity, and other nervous disorders. Yet important as are these congenital injurious influences, they are of far less moment than those harmful effects operating on the individual after birth. The entry of the child into the world marks the beginning of a struggle against unfriendly forces which lasts until death. Not only must the new being face the many possibilities of mechanical accident, but it has lying in wait for it a host of minute living enemies in the form of bacteria and other microörganisms. In order that these latter agents of injury should be successful against their human antagonists, they must not merely find a portal of entry into the body (as through the lungs or stomach, or eyes or ears, or

through the skin), but must have an opportunity to reproduce. When we consider for the first time how varied are the injuries that may be inflicted on the body by bacteria, we wonder how any human being manages to run the gantlet of his foes, and defying them all, attain to an old age. During infancy there are the many agents of infection for the digestive tube, leading to the death of enormous numbers of children under five years of age. Then there are the dangers of childhood from diphtheria, scarlet fever, and measles, the causes of the eruptive diseases being still unknown. The period of adolescence and early adult life is one of comparative freedom from the inroads of injurious bacteria, for it is a time of growing powers and strong defenses. Still, even at this time, the infections of tuberculosis and of typhoid fever claim many victims, while the entry on sexual life is like opening Pandora's box, in which lie syphilis, gonorrhœa, the dangers of maternity, and a host of more subtle agents of destruction. In middle life the powers of resistance are gradually lessened in all directions. The powers favoring decay are more and more successful in finding the weak spots in the armor, and, penetrating a little here and there, make those quiet or more obtrusive inroads on health which point the way of future decline. For it is a fact that by middle life — and often before — the tendencies of the tissues have declared themselves and are clearly visible to those who know how to look for them. In one, it

is a slight pathological change in the muscle of the heart which marks the beginning of graver alterations; in another, the arteries show alterations pointing to a special liability to ruptures or obstructions; in still another, the blood begins to exhibit an impoverishment which foreshadows progressive losses destined to end in a fatal outcome; or, again, it is the kidneys, the organs of blood purification, that show signs of being unable to do their duty. These various initial steps in the process of physical degradation may be compatible with what we call good health. The weak places may be revealed only during some period of stress — as, for example, during an acute infection. Then the feeble heart or high pressure in the arteries, or the striking pallor, or the refusal of the kidney to obey the calls on it, attracts attention to the presence of structural defects that cast their shadow into the future. The damage thus caused by acute infections in the course of slow processes of a degenerative or involutional character — the damage which thus draws attention to the weak parts of the machine — must be, in one sense, looked on in the light of an accident. For these circumstances which allow the entry of the tubercle bacillus, or the pus-making streptococcus, by some infective portal, are quite as subject to the element of accident as are the events leading to the fracture of a rib or the severance of an artery.

Having passed through middle life without contracting disease sufficiently grave to obviously im-

pair its workings, the human machinery is at last subjected to a multiplicity of degenerative tendencies, which, having usually had their quiet inception in middle life, now begin to obtrude themselves by giving origin to one or more disorders of function which result in symptoms of diminished capacity for work. The occasional disorder, the warning weakness, has given place to the permanent, the chronic enfeeblement. The chronic degeneration of the heart muscle, the fibrous and fatty and calcareous change in the blood vessels, the shrunken kidney, denuded in part of its degenerated epithelial cells, the established wasting of the working epithelial cells of the stomach and intestine, the impoverished blood, — these are some of the common results of the gradual physiological wearing out of the living tissues, and they are further aided and hastened by the acute bacterial infections, with which the organism has almost inevitably had to reckon from time to time. It is not surprising that these changes in the living protoplasm of the cells should entail a weakening of the defenses of the body as a whole, and that in consequence of this the period of senility should be one beset with the varied dangers of infection. Old age is, in fact, a period of susceptibility to almost every kind of bacterial danger, including gastric and intestinal infections, bronchitis, pneumonia, influenza, tuberculosis, and bacterial invasions of the kidney, bladder, and genital tract. Death may, indeed, come acutely with a final bacterial

infection from a mechanical accident to some part of a system of degenerated blood vessels, as from rupture of a blood vessel in the brain or the plugging of a nutrient artery to the heart. Or a degenerated heart muscle may suddenly, without warning and without discernible immediate cause, cease to beat, or the kidneys, long overburdened, may quickly cease their work and prove unamenable to any therapeutic coaxing to renewed activity. Indeed, among the aged we may regard as standard modes of death these sudden vascular accidents of the brain and allied circulatory failures in heart and kidney. But in many instances the last days of life are attended by bacterial invasions, often by several kinds of bacteria, which are known to the pathologist as terminal infections. These terminal infections, making their way after some prostrating pathological accident, or after an acute and specific infection, such as pneumonia, are the quiet means of giving the *coup de grâce* to a mechanism no longer able to defend itself.

From this formidable array of physical dangers, it is clear that to attain to sixty or seventy years of age is in itself no mean achievement, especially if these advanced years find the individual still free from the burdens of invalidism. How does it happen that of a hundred human beings that come into the world, only a small number reach that record of threescore and ten which the Bible has helped to establish as a standard of respectable longevity?

Why do so many drop by the way, or attain the goal exhausted? Many factors enter into the outcome — the primitive vigor of the cells, good habits of life, good fortune in avoiding accidental infections. The facts may be stated a little differently. We may say that the vigor of the cells, coöperating with careful habits of husbanding the energy of these cells, are most potent influences in helping the body to evade the dangers of bacterial infection. If it were possible to live without such infection, there is no doubt as to the effect on human life. Supposing, for a moment, that such a thing were possible, we should expect the cells of the body machine to deteriorate only very slowly, with the result that the duration of life would be, on the average, far in excess of what it now is. For we may consider that at the time of conception the possibilities, with regard to the future physical vigor of the cells, are expressed in the protoplasm of the new being. The events of impregnation are, indeed, not unlike the winding of a clock, newly endowed with the power to run for a quite definite period. Many things may happen to check the course of the clock, or to shorten its time of action, but under ideal conditions its run cannot exceed the course made possible by its organization. In exactly the same way, the span of each human life has set to it a definite limit in organization, imposed at the instant of impregnation. Many things may happen to rob the individual life of a portion of the life possible to it, but man knows

of nothing that can intervene to inject new potential. For the human clock cannot be wound anew, not so much as by a single turn of the key. In short, all that man can do to secure the full potential for which his organization fits him is to protect his slowly declining machinery from the innumerable insults that threaten it.

The surprising thing is not that the life of the human animal is so short, but that it is so long. If we compare the longevity of man with that of animals, we find it to be superior in all but a few cases, such as the elephant and parrot. For this relatively long life, there is a clear explanation in the possession of an elaborate system of defenses. With this system effectively operative, long life is possible; with it impaired, there must come disease or death, or both.

CHAPTER V

DEFENSES OF THE BODY

THE defensive methods of the body are inherent in the organization of its cells and fluids, and we cannot expect to fully understand them until physiology can command more refined ways of investigation than at present. Yet it may be said that slowly, and with infinite patience, important knowledge has been gained of the multitudinous ways in which the human organism rids itself of the influences that threaten it. Some of these ways have a simple mechanical end, as when coagulation of the blood sets in to stop bleeding from an artery — a defense necessary, not merely after an accidental cut, but after the exposure of the blood vessels after childbirth. This coagulation defense, so often called on and so fundamental, is in reality but incompletely understood despite the attention that has been given it. A very different type of protection comes from the almost universally distributed powers of oxidation that prevail in the body cells. The ability of the organism to break down larger into smaller molecules of foodstuffs simultaneously with the appropriation of oxygen is a primitive function, continuously in operation for the purpose of utiliz-

ing the nutritive materials of the body. This is, however, not the only use of the oxidative function. Many substances which the body admits to its juices have a dubious quality in respect to healthfulness, or even outspoken poisonous properties. This is not inconsistent with their having food properties and with their being attacked, like food, in the processes of oxidation. A simple but illustrative case is that of the fate of ordinary or ethyl alcohol in the body. It is a common occurrence for ethyl alcohol to gain admission to the human organism in quantities far in excess of what may be considered a harmless dose. The oxidizing mechanism promptly converts the alcohol into acetic acid, and this acid then takes the usual course followed by acetic acid of whatever origin (as from foodstuffs); that is, it is burned to the end products, carbon dioxide and water. Here, then, we have an example of a defense against a poison which consists merely in ranging the poison in line with the treatment accorded by normal cells to food products of similar constitution. But while this oxidative defense suffices for the disposal of some poisonous agents, it is by no means an adequate defense against others. For some poisons the cells provide a synthetic method of detoxication; that is, a method by which they bring about a union of the poison with a substance supplied by the body, the result of the union being the formation of a new substance much less injurious to the body than either of the original substances.

A case in point is carbolic acid. This substance is always made in at least very small quantities in the human intestine, and on being absorbed into the blood is converted by union with sulphuric acid (in the liver) into a new compound. Now, by virtue of this habitual synthetic defense, the body is able to dispose of much larger quantities of carbolic acid than it is ordinarily called on to get rid of. In a silent way, this is a highly useful defense, for it is no rare occurrence for the intestine to make carbolic acid in quantities injurious to the nervous system and other tissues, were it not for this specific protective power of the cells. And when it occasionally happens that a person recovers from a large poisonous dose of carbolic acid, this recovery is to be placed to the credit of these same synthetic powers that have been called in to operate on a large scale instead of in their habitual more limited way.

We may regard the oxidative and synthetic defenses as having a relatively simple chemical character, if we compare them with some other protective methods. Various more or less complex biological oxidative procedures may be combined with synthetic processes, but, generally speaking, these methods are not adequate to rid the body of its most dangerous enemies, the pathogenic bacteria and the poisons which they make. For more intricate mechanisms are necessary to cope with such invaders, and they are not wanting. Among these there are none more important than the white blood

cells or leucocytes. Nearly forty years ago Metchnikoff, the Russian biologist, saw for the first time that some of the white blood cells are able to pick up, surround by ameboid movement, and finally to destructively digest animalcules, bacteria, etc. This remarkable observation has been variously interpreted, but there has emerged from it one fact deeply significant for the bodily defenses. These primitive, unspecialized cells, the leucocytes, are able to surround and destructively digest bacteria which have entered the human blood stream, *provided* these bacteria have first been given the *coup de grâce* by other agencies. Fortunately the blood possesses in health a small but potent supply of highly organized substances capable of injuring various types of bacterial enemies of man in such a way that the leucocytes, attached to the invaded spot, can finally dispose of them. These substances were called opsonins by Sir A. E. Wright, who first discovered that the ability of the leucocytes to incorporate pus-making bacteria or tubercle bacilli or typhoid bacilli depends upon the existence of these opsonins. It is fair to think of these opsonins as highly complex labile materials which act as preparative sauces to bacteria, rendering them attractive and accessible to the finally destructive leucocytes. Some kinds of immunity or protection against special bacteria seem to depend upon this combined action of fluids and cells; and, on the other hand, a decline in opsonins causes a falling off in the capacity of the

leucocytes to take up bacteria, and hence a corresponding decline in immunity. For example, there are persons with persistent boils due to the pus-forming staphylococcus, in which the opsonins for these germs are reduced in activity. The activity of these opsonins can, however, be raised by suitable treatment, and simultaneously the boils disappear.

The fact that the opsonins for staphylococci can be raised in activity by injecting into the body of a susceptible person very small, carefully adjusted doses of the specific poisons formed by these germs is an illustration of a principle of great importance for the defenses of the organism. For it is now well established that there are a variety of poisonous substances which, on circulating in the blood, stimulate the cells of the body to form substances which are able to antagonize or neutralize any further doses of the original poisons. Such poisons may be called *antigens*, and the antagonizing substances to which they give the stimulus of formation may be called *antibodies*. The great investigator of immunity Professor Paul Ehrlich maintains that the antigens are absorbed by the cells of the body through chemical mechanisms like those used in the absorption of the foodstuffs. Consequently a poison may operate as such because it presents a chemical face like the chemical face belonging to nutritive substances — much as an enemy might be admitted to a man's house because he wears the mask of a friend. Having once gained admission, that is,

having made a suitable chemical connection with chemical groups in the cells, the poison proceeds to do damage to the cells. It is in this way that the body structures are injured in the course of disease by the action of bacterial poisons — probably the most potent and widespread way of damaging the body. If, however, the doses of the bacterial poisons are not too large, there arises another effect of a very different kind, a most singular, profoundly conservative effect. This is nothing less than the formation of protective substances by the somewhat damaged cells, substances which, owing to chemical groups which they contain, are able to unite with some of the poison that may reach the cells, and thus anchor it fast and neutralize it. Substances of this kind are called antibodies, and when such antibodies are cast off into the blood, — as they ultimately are when they have been elaborated in excess, — they receive the name of antitoxins. These antitoxins, or free antibodies, have thus the power of intercepting poisons by combining with them and hence screening the vulnerable cells from the damage which they would suffer if not so protected. The number of antigens, or substances capable of exciting the formation of antibodies, is considerable. The venoms of different snakes, the poisons formed by the bacilli of lockjaw and of diphtheria, are among the best examples of antigens from whose action may be derived antitoxins suitable for the treatment of human injuries due to these poisons. And it should

be noted that in each case the action of the antigen is specific. The antitoxin formed by the action of the diphtheria poison or toxin will neutralize diphtheria poison, but not lockjaw, and the converse is true.

Whether the antibodies and the opsonins are substances of the same chemical type, or distinct, is unknown and need not concern us in this general discussion, but it seems likely that different investigators, approaching the problem of immunity from different standpoints, have discovered identical or similar substances under different names.

There is still another physical defense of great importance to the maintenance of life, but of a nature wholly different from any that has been mentioned. This is the protective action of the microörganisms that occupy the digestive tract. It is well known that throughout life, from a few hours after birth, the human intestine swarms with bacteria. It is less well known that in healthy people these inhabitant bacteria possess a clearly defined biological character which varies within not very wide limits for the same individual and even for different persons, provided the diet remains reasonably constant. There is not the least doubt that in some way — a rather intricate way — these normal and dominant flora of the intestine exert a protective action on the entire body. This protective action is complex in operation, but consists at least in part of a preëmptive effect on the intestinal domain, by which other types of bacteria are in large degree

excluded. It is impossible to avoid introducing into the digestive tract many bacteria which would prove undesirable permanent tenants, and these are successfully discouraged from gaining a foothold by the motile biological activities of the more permanent and better adapted bacterial guests. But to maintain this supremacy, the normal flora depend upon certain conditions of food, on the one hand, and of secretions from the epithelium and digestive glands, on the other. The secretions may be so altered by nervous conditions, or by actual disease of the epithelium, that the preëmpting flora can no longer maintain themselves. In fact, they gradually (or sometimes rapidly) suffer displacement to a considerable extent by microörganisms capable of leading a life injurious to the secretory structures of the digestive tract and to the organism as a whole. M. Metchnikoff has long maintained that the replacement of the normal bacterial flora by "wild" intrusive races is a potent cause of chronic disease, and of curtailment of life, and I have long held and taught similar views based on wholly independent study. We have still very much to learn regarding the details of this unique partnership between the human body and the bacterial parasites which inhabit it with advantage to host and to guest, but it is quite safe to make the far-reaching generalization that all influences which aid in maintaining a normal bacterial flora are factors in the avoidance of disease and in the maintenance of long life. Strenu-

ous but not highly intelligent efforts are being made to utilize this principle by advising the rather promiscuous use of milk containing bacteria which form lactic acid abundantly, and are hence regarded as discouraging the growth of life-shortening putrefactive bacteria in the intestine. Although this practice has received the public sanction of Professor Metchnikoff, it seems destined to excite false hopes and to bring into merited disrepute a procedure which, more carefully controlled, is likely to prove of real service in at least some affections. To establish the value of milk or other food fermented by any special bacteria introduced as defenders of the normal flora conditions of the digestive tract, very prolonged and painstaking investigations are called for, and it is regrettable that premature efforts in incompetent hands should jeopardize a promising measure. It may already be regarded as certain that the *Bacillus vulgaricus*, which has been so widely advertised, is no specific for the cure of diseases of the intestine or for the prolongation of life. On the other hand, it is true that all of the defensive measures that have been here summarily reviewed — and others which have been passed over in silence — give us important clews to the right procedure for prolonging human life; namely, the maintenance of the natural defenses of the body by all habits of life that are conservative of these defenses, and especially by such habits as wholly avoid the entry of injurious bacteria.

It has been pointed out that the main cause of disturbed health is the entry of pathogenic bacteria into the body, and it has been intimated that the injury inflicted by these bacteria arises in consequence of poisons formed by them. It appears to be true that analysis of the facts relating to disease shows the occurrence of poisoning to be the essential cause of nearly all departures from health. In saying this, it is meant to use the term "poisoning" in a very broad sense, to include every injurious effect due to the accumulation of chemically acting materials in any portion of the body. If we think of poisoning in this sense, we are at once brought face to face with the realization that there is really no sharp line of demarcation between health and disease. We are accustomed to think of disease as something quite distinct from health, just as moralists are apt to think of evil as something easily separable from good. Close scrutiny shows us that a clear distinction is as little possible in one case as in the other, in at least a considerable group of instances. A specific instance will serve to make this clear. It is a fact that in childhood the process of intestinal digestion is carried on, in very many individuals, for long periods at a time with singularly little putrefactive decomposition, despite the millions of bacteria present. The absorption of certain putrefactive products is therefore minimal in these children. Often, however, we find children in whom these substances are formed and absorbed in moderate amounts. Yet

to the ordinary methods of observation there is no sign of derangement of health, no indication of impaired function, although we are well aware that these putrefactive substances have distinct poisonous properties. In these cases, we cannot say that there is disease. This is out of the question in any ordinary sense of the term. Yet we know that a further exaggeration of this process of poison absorption will lead surely to the development of symptoms and entry into the realm of the definitely pathological. So we have to recognize that we are dealing with a condition on the borderland between health and disease. There are very many examples of states which cannot be strictly called disease, yet cannot be classed as physiological. The study of such states has shown us clearly that, in general, we must regard disease, not as a vicious something wholly foreign to the body and able to invade it, but as the expression of slight, considerable, or extreme derangements of biological processes. The healthy, animal organism at any given instant represents a combination of functions in which the balancing of opposing tendencies is a prominent feature. A perfect balancing of opposing tendencies makes for inaction and stability, while oscillation in balance within narrow limits is characteristic of normal activities. On the other hand, a disturbance of the balance between opposing functions, leading to wide oscillations or to the partial or complete suppression of one of two opposing tendencies or activities, constitutes disease,

provided this disturbance be more than transitory or sufficiently marked to give signs or symptoms. An instructive illustration of the injurious effects of disturbed balance of forces may be drawn from the pathology of inflammation. The white blood cells or leucocytes carry ferments capable of digesting destructively the bodies of bacteria that have been suitably prepared by the action of the blood. These ferments are of such a nature that they would digest the cells of the body itself, were it not for the fact that these cells are protected against this kind of injury by a ferment (called an antiferment) which opposes the action of the ferment carried by the leucocytes. In conditions of local inflammation, the leucocytes may accumulate in one spot to take up invading bacteria, but in doing so they may liberate an amount of ferment that suffices to overcome the protective antiferment which the cells oppose to them. The result of this excess is that the tissue cells, no longer able to balance the action of the leucocytes, pass into solution with the result that an abscess is formed. Another example of a want of balance, resulting in disease, is seen in the singular condition of thickening of the skin, associated with mental hebetude, which physicians call myxœdema. This disorder appears to be entirely due to a defective secretion of certain juices formed by the thyroid gland, the administration of normal thyroid extract leading to the cure of the disease. On the other hand, the thyroid gland may secrete its juices in

excess, and this leads to a wholly different set of manifestations. Here, then, disease is caused either by a deficiency or excess of a normal secretion — by the agency of disproportion. Another striking example of the same phenomena is seen in the way in which ulcer of the stomach arises. The mucous membrane of the stomach secretes a juice capable of digesting meat fibers, yet it is a remarkable thing that this juice fails to digest the stomach itself. The living cells of the stomach are able to resist chemical conditions which the dead or dying cells cannot withstand. The power of resistance which these cells exhibit seems to depend on their possessing special ferments capable of defying the powerful digestive ferments of the gastric juice. Under certain pathological conditions, the resistant ferments are probably lost in a portion of the mucous membrane of the stomach which consequently becomes helpless to the attack of the gastric juice, and the formation of ulcer results. In many cases, the lack of balance in physiological powers is less plain, but still probable. So in cancer the invading cells run riot, probably because the habitual restraining forces of these cells have been in some way lost.

In general, it seems correct to regard the processes of disease as differing from those of health in a quantitative, rather than a qualitative, way. A living cell, like a liver cell, may be considered as a field within which there is a largely independent play of distinct processes — each process being

carried on with its individual rhythm. There is some resemblance between such a field and a room containing a number of different machines operating each with its own rhythm. Each of the machines can be accelerated or retarded in rhythm, but such change in rhythm causes no change in the quality of the function — the clocks, for example, develop no new function in consequence of ticking more rapidly or more slowly than they should. It is difficult to believe, at first sight, that deranged cells develop no new products or powers, but this seems to be the case. Whether a cell is deranged by errors inherent in organization, by the action of bacterial poisons from without, or from the action of drugs, the effect is the same in type. There is retardation or acceleration of function, but probably no new development of function. When we find in the blood or urine substances that seem wholly strange and abnormal, we are disposed to regard them as something quite novel. When we look more deeply into the physiological processes, we see in every case that these pathological substances have their origin in accelerations or retardations of normal function. One example must suffice. The urine of diabetic persons may contain a considerable amount of an abnormal constituent known to chemists as a variety of oxybutyric acid. In health no trace of this acid is detectable in the urine. Whence does it come in disease? For a long time it was impossible to correlate this unfamiliar substance with any physio-

logical process or constituent; it appeared to many as the intrusion of a wholly inexplicable and unrelated cause of disease. Philosophically-minded investigators had faith that in time the oxybutyric acid would be found to stand in some clear relation to physiological processes, and this view has been amply justified by recent studies. For it has been shown that this obscure acid comes from the normal oxydative breakdown of fatty acids. In health the acid exists in mere traces only, because it is burned to simpler substances as quickly as it is formed, thus serving as a source of energy. But in diabetes, the power of complete combustion is lost, and a portion of the acid formed escapes unburned into the urine. What seemed a new and unrelated substance is, in reality, only a physiological constituent that has been subjected to a great quantitative change in consequence of a partial breakdown in the oxidative mechanism.

There has long been a disposition to make a sharp distinction between structural and functional diseases. It is important to realize that disease is, in its essence, the expression of functional derangement, and that disturbances of function, however slight in degree, imply structural alterations of some grade, even though these be undetectable by present methods of investigation. The standards of judgment in respect to structural disease vary from generation to generation as methods grow more refined and searching. Even to-day we have definite

examples of disordered function without being able to detect the structural substratum of this change, but this fact should not blind us to the legitimacy of the theoretical conception that every change in function (even within physiological limits) is based on alterations in the structure of the living protoplasm. Only when these alterations are so profound and so permanent as to entail a lasting decline in function (or an excess of function due to the suppression of balancing restraining factors) does the disease take on an irreparable character.

CHAPTER VI

SELF-PRESERVATION AND THE MENTAL LIFE

I

Enough has been said of the nature of physical disease and of its various causes to show how manifold are the influences that must be taken into account in any intelligent effort to prolong human life under conditions of maximal bodily efficiency. It now remains to consider the mental influences that affect the duration of life and, what is equally important, the satisfaction and efficacy of the mental experiences that enrich consciousness. I have tried to give the reasons for thinking that the gap between mental activity and physical activity is not so wide as is generally supposed, and that consciousness itself must be regarded as the expression of the most refined form of physical activity, a form of activity subserved by an extremely complex type of machinery which transforms and liberates energy under conditions at present undefinable, owing to lack of experimental knowledge. I shall try to show here that the mental life, or the content of consciousness, stands in the most intimate relation conceivable to physical conditions, partly inherent in the organization of the brain, and partly dependent on fleeting stimuli brought to the brain from without.

It is now well recognized that structural defects or alterations in the brain entail corresponding disturbances in the mental life. Among the most marked defects of this nature are those due to imperfect development of the nervous system consequent on faults in the germ cells or on disease or injury to the fetal, or infantile, brain. This arrest in development gives rise to the profound disorders seen in idiocy and to the somewhat less serious ones of imbecility. Speaking generally, it may be said that there is a fair degree of correspondence between the defects of development of the cerebral rind or cortex and the defect in mental capacity. The brains of idiots and imbeciles are nearly always below the normal weight, and in a general way deficient brain weight means mental defect. But it is only where the brain weights are very low that we can admit so gross an indication as a sure sign of the grade of functional capacity. It is a fact of the first importance, that mental function is an expression of cerebral organization rather than cerebral bulk. The largest brains that have been recorded have belonged to individuals of moderate capacity. Some great men have had brains of small or moderate size. In those cases where a brain of abnormally large size has coincided with unusual eminence, as in the case of Webster and Cuvier, it is probable that the individual has had the benefit of refined organization as well as of great mass.

For the study of the parallelism between structure

and function there is instructive material in those regressive changes which develop in the brains of persons who have been previously without noticeable mental abnormalities. In such persons the demonstrable alterations in structure may be either localized or diffuse, and the nature of the resulting functional defects is correspondingly stamped. The diffuse lesions are common causes of disorders of personality, in which a general memory defect and general mental failure or dementia are prominent. There are two diseases in which such disorders of personality are very striking — general paralysis of the insane and senile dementia. Both are diseases in which the cortex or rind shows a progressive decay. The highest faculties of mind and personality have their physical seat in the cortex of the brain, and with its slow disintegration there is a pitiful deterioration of judgment and character with loss of memory, tremor and defects in speech and writing. In both these diseases there is a fair correspondence between the mental loss and the physical alterations of the brain. There are, in fact, no better examples of the dependence of personality on the integrity of quite definite physical structures.

Where there are localized defects of the cerebrum we get a different order of brain disturbances, in which there is no actual mental disorder in the ordinary sense, unless, indeed, there are implicated those parts which subserve certain very special kinds of mental activity, as, for example, the organs of speech

and speech elaboration. It would be aside from the purpose of this discussion to describe the effects of disease in different regions of the cerebrum. A vast accumulation of careful observations has enriched cerebral pathology, and from it there has sprung up a science and an art of cerebral localization which has been of the utmost service to medicine. But many of the local defects of the brain are of interest chiefly for their effect on functions other than mental, such as motion, hearing, and vision. All I desire to point out here is that each hemisphere of the brain is related mainly to the opposite side of the body, and that each hemisphere may be roughly divided into a posterior area, carrying on in part the functions of perceptive discrimination, and an anterior area (in front of the fissure of Rolando), subserving the final elaboration of executive activity or motion. A variety of circumscribed defects in different parts of the cerebral cortex lead to special disorders of function, as when a loss in the occipital cortex of one hemisphere causes half blindness in each eye, or when the defects in hearing centers in the temporal region cause an inability to understand spoken words and even the loss of ability to arrange words discriminately in spontaneous thought and speech. Frequently, also, there are defects of combination or elaboration in which the correlation of the auditory, visual, and labile components of speech or thought is involved. Such an involvement interferes profoundly with the general powers of the individual to

adapt himself to his surroundings. And one further fact of great interest in this relation may be mentioned. If disease implicates the internal capsule (the bands of nerve fibers converging from the rind on their way to the base of the brain) so as to interrupt the fibers coming from both frontal lobes of the brain, there is a very striking loss of emotional control. There is no sadder sight than a person who has suffered injury to the cerebral machinery in these parts, for although the lesion may be small, it suffices to occasion a degree of painful emotion that cannot be witnessed without arousing vivid feelings of pity. This one fact is all we know definitely about the emotions in their relations to strictly local lesions.

A large array of facts might be paraded to emphasize the dependence of brain function on structural integrity, but this is unnecessary. The doctrine of the existence of definite "centers" in the brain is established beyond question. It is, however, only fair for us to admit that our knowledge of these centers is still imperfect and far from what we desire. We know that the cerebral cortex can be divided into areas, showing distinct differences in microscopical structure. But the details are lacking in respect to the intimate organization of these parts. We cannot even say that the anatomical fields of the cortex in their structure coincide closely with the functions revealed by experiment and by pathology. The glib talk about the depositing of memories and

the creation of brain centers by practice is a mere play of words — a postulate from the facts of functional experience, lacking in histological demonstration. It is what Professor Meyer aptly terms "metaneurology." The centers grow by the force of growth and then develop from use, but only where the conditions are suitable. It is definitely wrong to say that in word centers each word has its own new cell, for a partial lesion always deprives people of the more unusual words first, and not special sets.

So much, then, for the disturbances of the mind that depend upon definite and gross structural alterations in the brain. Obviously such physical alterations cause changes in the mental functions which tend both to shorten life and to destroy efficiency and happiness. But these definite lesions of the brain, common and important as they are (especially as the result of arterial disease), form only a small part of the influences that operate detrimentally on the human mind. There is, in addition, a literally immense group of nervous and mental derangements, some slight, some severe, which have a wholly different origin. It can be said, with the utmost confidence, that most mental disorders and most nervous derangements are not due to alterations in the brain that can be detected either by naked eye inspection or by the use of the microscope. Yet it is true that every mental disorder rests on a disturbance of cerebral function. Many of these disorders are of so slight a grade that there is no question about

legal responsibility and no loss of ability to care for personal interests. Still even these slightest grades of mental disorder are due to cerebral disorder, and their origin cannot be sought in any other direction. When it is said that mental disorders, not associated with demonstrable alterations in the brain, are nevertheless of cerebral origin, it is not meant to imply that there are no structural changes in the brain. It is only intended to imply that whatever changes may exist are not demonstrable by our present methods. And that this is no reflection on the science of mental pathology will be quite evident to any one who will take the trouble to consider the unparalleled complexity of the cerebral organization with its uncountable nervous elements, structurally and functionally connected in unthinkably many ways.

In order to gain some insight into the nature of this supremely important group of mental disturbances, it is essential to realize that human beings are born into the world with nervous systems very unequally susceptible to those disorders of the brain for which one cannot at present find a structural basis. While some nervous systems have that in their organization which renders them extremely susceptible to mental disorder, there are others so constituted as to resist successfully within limits many of the most common influences that precipitate mental disorder. It is only right that, at this point, we should freely admit our complete ignorance

of the essential differences in the physical constitution of brains of these two types. We may speculate as to the nature of these differences, but it cannot be pretended that we have facts on which to support any speculations. The real explanation may lie in the nature of the protoplasm of the nervous material that makes up the brain, or it may lie in the arrangement of the nervous elements — we have at present no satisfactory methods of investigation in either of these directions.

But the mere fact that brains are of such different types in respect to this susceptibility to mental derangement is of basic importance, because it makes clear the reason why two individuals, subjected to exactly the same injurious influences, react to them in wholly different ways. Moreover, these inborn differences in organization give us the clew to the proper forestalling of such disorders — namely, the elimination of all injurious stimuli. We cannot change the make-up of the brain, but we can change the environment which is constantly flooding consciousness by means of stimuli of all kinds.

One other fact of deep significance is plainly obvious. A large proportion of the susceptible brains are found in persons whose heredity is not above criticism. If we examine into the parental characters of these susceptibles, we find that nervous disorders, diseases of nutrition, intoxication from alcohol, syphilis, etc., are especially common. If we examine into the parental characters of those who are rela-

tively insusceptible, who show what we call mental stability, — we find, in general, that they show freedom from nervous and mental diseases, good nutrition, freedom from intoxication, from alcohol and syphilis, and a tendency to longevity. Could nature give us a more impressive hint as to what society should strive to do for the elimination of mental disorder?

Let us now review the influences that are capable of disturbing the mental functions, especially in the susceptible, but also in those who are relatively insusceptible. It is quite impossible to get a fair conception of the nature of mental and nervous disease, if we fail to scrutinize these influences.

There are two main paths by which the brain may be approached, and, so far as we are aware, only two. These are the blood vessels with their lymphatic connections and the nerves of sensation. A liberal supply of blood is necessary to maintain the functions of the brain, and the blood vessels which serve to transmit this blood serve also as the avenues for the approach of injurious substances, or substances capable of modifying profoundly the functions of the brain. A physiological example is the carbon dioxide of the blood, an excess of which, carried to the brain, quickly ushers in loss of consciousness. Then there are the bacterial poisons that give rise to fever. These poisons, on coming in contact with a definite part of the brain, cause nervous changes that result in a rise in tempera-

ture, and if this rise of temperature is sufficiently great, the patient passes into that state of excitement which we call delirium, in which there is a marked disorder of personality. There is a remarkable example of the effect on consciousness of poisons locally produced in the blood vessels supplying the cerebral cortex. In the disease known as the African sleeping sickness large numbers of negroes are infected with a peculiar parasite which finds its way in large numbers into the vessels of the cortex and excites there a slow inflammation. The subjects of this disease fall into a deadly sleep from which they can be partially aroused only with difficulty for a few minutes at a time. There has been discovered a preparation of arsenic which destroys these parasites and rescues the infected subjects from the otherwise fatal sleep.

Many examples might be cited of poisonous substances which diffuse from the blood into the brain, and give rise to loss of consciousness by passing into solution in certain constituents of the nervous tissues. Alcohol, ether, chloroform, and a host of drugs belong in the class of diffusible anæsthetics and narcotics, which in their action are largely controlled by simple physical laws. A simple but telling experiment can be made to show the readiness with which some of these substances diffuse into the nervous system and out again. If a lively tadpole be placed in a one per cent solution of ordinary ethyl alcohol, he will gradually become

quiet and will, in a few minutes, cease to move, although the heart still continues to beat. On transferring the animal to plain water, the alcohol which has passed into the brain by diffusion finds its way by diffusion into the water, and the activities of the tadpole are soon resumed.

There are a great many forms of physical disease in which substances are formed which disturb the functions of the brain. The pus-forming bacteria, the bacteria of influenza, and many others make poisons that irritate or depress certain brain centers. In diseases of the kidney, of the liver, and of the intestine there are formed poisons which may prove very injurious to the brain and induce a variety of mental and nervous derangements. I shall limit myself to one example of this sort, the effect of chronic intestinal infections.

It has already been pointed out that, in health, the human intestine contains bacteria possessing certain protective functions, and that in disease the normal bacteria are in part replaced by others. These substituting bacteria form poisons which, after absorption from the intestine, are carried to the liver and rendered harmless there by means of special protective methods. It may readily come to pass that the intestinal poisons, finding their way to the liver, are not wholly neutralized there, but in part slip by this guard and find an entry, by the blood, into the helpless brain. A variety of poisonous effects may in this way arise. Our knowledge of the

individual poisons and of their specific effects is still meager, owing to the great technical difficulties that surround the investigation of these substances. But of the truth of the following statement there is no question. There are many conditions of slight or considerable mental disturbance in which irritability, depression, or confusion of thought is due to intoxication of the brain from intestinal poisons, and in these cases there is a rapid return to a normal state when this intoxication ceases. The suffering caused by such poisonings is real and great. It affects not merely the happiness of the subject of the intoxication, but, through its influence on conduct, his associates are also implicated. When temperamental peculiarities exist, they may be greatly exaggerated by a state of intoxication and produce distinctly regrettable results. And one of the most unfortunate features of these poisonings, especially when they are established, is that their true nature is commonly not recognized, so that a disorder is permitted to persist which might be mitigated if met in timely fashion.

Let us turn now to the hundred avenues of direct approach to the brain by the nerves that focus there from all parts of the body. If we consider, even casually, the great sensory pathways to the brain, we cannot fail to be impressed by the opportunities that normally exist for the most varied stimuli to register themselves in the cerebral hemispheres. The chief of these stimuli come through the skin, the

muscles, and the internal organs. Existing physiological knowledge of this subject was materially deepened by studies made, not long ago, by Dr. Head of London, who, in order to investigate the sensations from the skin, caused certain nerves near his own hand to be cut, and afterwards examined his arm and hand systematically. In this way he discovered three distinct forms of sensibility. One of these Head calls deep sensibility, supplied to the deeper structures by nerves running in company with the motor nerves. The skin itself was found to have two distinct forms of sensibility, one (the epicritic) by which it is possible to detect light touches and impressions of warmth and coolness; a second (the protopathic) which is not evoked by light touches, but by comparatively deep pin pricks, or by heat or cold, or by touching or pulling hairs. The protopathic sensibility has the peculiarity that an intense stimulation gives a distinct, though not usually localized, pain of widespread and radiating character. When located, it may not be at the point stimulated, but at a considerable distance. The two systems, the epicritic and the protopathic, though largely distinct, show intimate relationships. There appears, moreover, to be a distinct analogy between the sensibility of the viscera and that subserved by the protopathic system, and, indeed, their nerve supply is part of the same mechanism. Head found that heat and cold applied within the walls of the intestines were referred by patients not to the

viscera, but to the skin, or, strangely enough, to the air. But even now a full knowledge of the visceral sensations is lacking. Yet we know enough to realize that while the visceral sensations in general do not rise into consciousness (or do so only vaguely), they are capable of influencing the emotions and, at times, of arousing very definite mental states. Finally, an extremely significant source of sensory impulses in the brain is the pathways of the special sensory nerves, the olfactory, visual, auditory, and gustatory.

When we realize the extent of the sensory mechanism and the variety of its forms of sensibility, it is easy to understand how disease, often slight in its development, may so implicate the sensory mechanism as to send abnormal stimuli to the brain itself, yet without exciting definite pain. Chronic affections of the sensory system, involving the special senses, the skin, the muscles, or the viscera, often serve to excite excessive reactions in the sensory recording apparatus in the brain. If the reactions are painful, they are so obtrusive as to invite remedial interference. But very commonly the stimuli are not of a painful nature. They are on this account none the less effective in causing emotional or mental disturbances. Vague sensations of discomfort, often inconstant and not easily described or localized, make their way into conscious life and serve to deprive the individual of comfort. The incubus of such stimulation may be, in time, sufficient to interfere with the smooth working of the finer cerebral

mechanisms that habitually hold in check the emotions, or may even account for irritative discharges of nervous energy from the special sensory centers of the brain. In the former case, there may arise emotional outbreaks constituting irregular conduct; in the latter case, there may be hallucinatory excitement which, if uncorrected by the force of logical intellectual processes, may lead to irrational thought, speech, and action. And it is true that the abnormal sensory stimulation which shows itself in such mental aberrations may rise into consciousness with hardly enough definition to enable the subject to take cognizance of it as a distinct disturbance. An impaired tooth, an ulcer of the stomach or colon, a displaced uterus, an enlarged prostate gland, may each furnish sensory stimuli capable of inducing, directly or indirectly, disorders of a mental nature in persons whose nervous systems are sensitized by other injurious agencies, or by inherent organization, so as to give them the vulnerable quality of instability.

Medical science has still much to acquire in knowledge of the causative processes that lead to those disturbances of functional balance in the cerebrum which constitute nervous and mental disorders, and it is far from the purpose of this essay to attempt to point out these needs in detail or to supply them. Nevertheless, no intelligent discussion is possible of the self-preservative instinct which so largely molds human personality without taking account of the

rational basis of deranged nervous activity. We have seen that the cerebral centers may be influenced through two pathways, the blood stream and the sensory nervous mechanism, and it has been pointed out that a variety of chemical and mechanical agencies are capable of operating as disturbing factors. I have, however, failed to emphasize three considerations which are essential to enable us to think clearly of the phenomena of nervous and mental derangement in their bearing on human longevity and efficiency. These are, first, the multiplicity of disturbing factors operating by way of the blood stream and the sensory system; second, the nature of the erroneous life habits that set these disturbing factors in action; and, third, the powerful effect of hypnotic suggestion on the functional activities of the brain.

There is a tendency to ascribe mental derangements (including in this term the slight manifestations which make borderland cases) to single causes, although in reality the factors are commonly multiple. Often it happens that some one agent is conspicuous, and the true determinant of the actual disorder, but careful study will usually show that there are associated auxiliary elements in the chain of causation. Psychical causes, mechanical causes, and toxic causes are often associated in bringing on the derangement, although one or other of these types of noxious influence may have been operative longer than the others. Thus a chronic intestinal

infection may so poison the nervous system, in an insidious way, that a powerful mental shock, in itself insufficient to overcome the nervous stability, now suffices to break the equilibrium which has been before maintained with slender margin. Or the use of alcoholic drinks may have paved the way so effectively that a relatively mild illness from typhoid fever or pneumonia finds the nervous mechanism uncommonly vulnerable to toxins which would ordinarily have been prevented from precipitating the disorder of personality or the severe nervous disorder. Instances of such duplex causation might be multiplied, and even more complex instances of causative action could be pictured. What has been said must suffice to illustrate the principle at issue.

That erroneous habits of life play an enormous part in creating weaknesses is an incontrovertible commonplace, but, nevertheless, one that is too little heeded. Faulty life habits operate through the life channels that have been already described, through the creation of foci of irritation in the sensory paths and through encouraging the access of poisonous materials to the cerebral centers. It is worth while to give a list of the more important faulty life habits and then to give some examples of the way in which they lead to the disturbance of cerebral function. It is a short and prosaic list made up of the following items: the improper and excessive use of food, including the abuse of alcohol, tea, and coffee; the overfrequent repetition of sexual excitement; the exces-

sive application of the mind in intellectual pursuits; the reception of an excessive number of emotional stimuli through the special senses of sight and hearing. To this list might be added the overuse of the muscles, but it is questionable if this is often an important element in the absence of the other factors. The improper and excessive use of food is one of the commonest factors in bringing about physical disorders which determine mental and nervous ones. They can be avoided only through the use of exceptional judgment and self-restraint. The tendency to eat in excess is almost universal at present, for people are guided by appetite rather than by their needs. Every human machine has a definite and ascertainable food requirement, and to exceed this is as unwise and as uneconomical as to exceed the coal requirements of a locomotive engine. In time, educated people will take the trouble to learn their individual nutritional requirements and will take pains not to exceed them. The ill effects of excessive sexual excitement are even less understood by people than the effects of improper diet. The central fact is that excessive sexual excitement exhausts the nervous system. This causes a depression of the secretions necessary for digestion in the stomach and intestine, and this, in turn, permits the overgrowth of undesirable bacteria in the digestive tract. This overgrowth causes erroneous decompositions in the food, permanent alterations in the mucous membranes, and the formation and absorption of

substances capable of injuring the brain. The damage done the nervous system in this way still further depresses the digestive secretions, and in this manner a vicious circle is established, which it may be very difficult to break. Nervous disorders of a depressive kind and blood disorders are the commonest results of such conditions, if they be long continued. The effects of excessive intellectual application are similar to those of sexual excitement, for, like these, they depend primarily on nervous exhaustion. But they are, in general, less pronounced and are, from the nature of things, much less frequent. Very similar effects, too, result from a life characterized by appeals to the emotional side of human nature. An excessively emotional life is very common in the competition of the ordinary business life, very common, also, in the struggles for social success which form so important a part of the modern life of women. When people become aware of the dangerous nature of the demands which are made upon them by these emotional expenditures and those incidental to sexual experience, they will strive to keep them within reasonable limits. And it will then be seen that in the endeavor to do this there will be a nearer approach to the realization of the best standards of conventional ethical teaching.

II

The effects of suggestion on mental life are so powerful and far-reaching that they cannot safely be

ignored by the student interested in the biological aspects of human instincts. The influence of one mind on another has long been recognized as a strong force for good or evil, and in a thousand ways the influence of suggestion is now recognized in social and religious phenomena. In very different spheres of human activity leaders of men, as Christ, Savonarola, Napoleon, Bismarck, and Pierpont Morgan, have unconsciously employed the impressionability of less powerful or differently constituted minds in order to gain their ends. The remarkable religious movement initiated in the United States by Mrs. Eddy has its basis in the heightened suggestibility and impressionability of the mind that results from a powerful emotional appeal which stimulates the emotionally controlled faculties of the mind at the expense of the analytical. It has long been recognized that the control of one mind over another may be heightened in certain directions by means of slight sensory effects obtained in the procedures which result in the state called hypnotism. In hypnotism we have a state of artificially induced mental abstraction — a sleep in which consciousness is limited or dissociated. In this state there is a condition of heightened susceptibility to suggestion. It is this increase of suggestibility which is the essence of hypnotism, and not the state of sleep, for this sleep may be very slight despite a greatly heightened sensitiveness to suggestion — indeed, sleep may be lacking. In the hypnotic state

a slight, unemotional suggestion delivered in words may act as powerfully as an extremely emotional suggestion in the waking state. These suggestions may take the form of acts to be carried out after waking or during the sleeping state. There is no doubt whatever that persons in the hypnotized state can frequently be influenced to a line of conduct at which they would rebel under ordinary conditions. There are well-authenticated instances where a drunkard has been suggested into a disgust for his liquor, and where his will has been reënforced to cope with temptation. Similar cases could be cited in respect to multiple and various vicious habits. The physiology of this influence cannot be analyzed in precise and satisfactory terms. Apparently what happens is that consciousness is so dissociated that the suggestions of the hypnotizer take precedence over other influences coming by way of the senses, the patient's own volition being, for the time, inhibited. Under carefully restricted conditions it seems entirely reasonable and moral to make use of hypnotic suggestion to inhibit by the psychical influence those injurious impulses which stand in the way of healthful impulses. Children are commonly susceptible in a remarkable degree to the example and precept of their parents, and this fact gives a powerful educational leverage based on sound respect for authority. The sensitiveness and inexperience of the growing child make the concentrated parental influence peculiarly effective and impart to this in-

fluence a suggestional quality comparable to that gained over adults by the aid of hypnotism. The parents have the enormous advantage over the hypnotist of being able to employ their influence frequently and at short intervals, and at chosen times. The weakness of hypnotic suggestion lies in the difficulty of employing it with such frequency and at such times as will make it most effective in forcing the right choice of conduct on the subject when the better influences are in danger of being overcome by evil ones. And again, there are many persons so constituted and of such a grade of intelligence, sensibility, and will that they cannot lend themselves to effective suggestions either in the waking state or in sleep. But as to the morality of attempting such suggestion, we should feel no more doubt than we do as to the morality of influencing a child by the methods of education or the appeals of art or religion or patriotism. Yet the cases for the use of hypnotism must be chosen with the utmost caution and intelligence, and hypnotic suggestion should be used only after suggestion in the waking state has proved of no avail.

How far is it possible to modify physiological functions by means of hypnotic suggestion? This is a question of real significance for every one who wishes to weigh intelligently the many claims which are made in a hundred forms to-day all over the western world. For our opinion of what is accomplished at Lourdes, or by Christian Science, or by the

Emmanuel Church movement, will depend upon what we believe hypnotic suggestion to be capable of — assuming, of course, that these phenomena do not require supernatural forces for their explanation. Professor Janet says that "there is no physiological function which is exempt from modification by hypnotic influence, if not complete control by it." Extreme as this statement is, it is not beyond the possibility of being true. We cannot define with exactness the limits of hypnotic influence. It does not greatly help us to say that its action is confined to the modification of function as distinguished from structure, for the line between the structural and the functional cannot be sharply drawn. It is certain that the vasomotor system of nerves is, in a measure, under the influence of suggestion. The proof of this is that in some persons we cause a local reddening of the skin by insistent suggestions bearing on the region in question. This occurrence is of the same order as a blush invoked in one person by the speech of another; the hypnotic vasomotor influence is, in general, exertable within a wider area than the phenomenon of blushing, and is inducible with more difficulty outside the facial area. But if the blood supply to a part is in a manner regulatable by suggestion, then it follows that the nutrition of that part can be modified in some degree, and modification of nutrition is inseparable from the refined forms of structural change. I know of no proof that the trophic nerves — which control

nutrition in skin muscles and joints — are under the influence of hypnotic suggestion; on the other hand, there is no positive evidence that there is not some degree of control over the trophic nerves by hypnotism. These considerations make it clear that it is no chimerical thought that suggestion may favorably influence a variety of slight nutritional disorders where these are related causally to functional nervous disorders. That an advanced structural disease is modifiable through the agency of suggestion of any kind is a preposterous and untenable doctrine, yet even here the skeptical medical materialist is compelled to make some admissions contrary to prevalent professional ideas. Two examples of this influence on definite structural conditions must suffice. In well-marked chronic gastritis of a certain type the damaged epithelial cells may be hindered from repair by the maintenance of an adverse mental state of depression, and powerful suggestion may so alter the nervous influences excited through the vagus nerve that an important obstacle to recovery is removed. Again, there are cases of paralysis of a leg or arm, from a structural lesion in the brain, in which hypnotic suggestion — strange as it may appear — is followed by a better use of the weak member. There is the best reason to deny that this effect is due to a direct action on the lesion. The explanation of the betterment lies, perhaps, in better blood supply to slightly damaged outlying regions of the lesion of the brain.

This superficial discussion of the effects of hypnotic suggestion may properly serve to introduce a brief consideration of Christian Science and the Emmanuel Church methods in their relation to suggestion.

The circumstance that so many thousands of human beings, not of the meanest intelligence, have turned to mystical methods of gaining relief for their mental and physical disorders is not intelligible, unless we think of it in relation to the medical profession. It is self-evident that if the recognized methods of medical practice could give satisfactory relief to this class of sufferers, they would not have deserted the conventional practitioners. The truth is that these practitioners have distinctly fallen short in two ways — in not greatly helping their patients and, what is equally serious, in not taking a sympathetic and intelligent interest in troubles partly imaginary and defiant of rational analysis. It is not surprising that the busy physician, occupied in combating serious structural disease, jeopardizing to life, should sometimes turn a deaf ear to vague troubles of a largely subjective nature. But he has often gone too far in ignoring these troubles, and has frequently overlooked the actual physical basis of nervous and mental disturbances. The reason for this is sufficiently plain. The medical school teachings are confined to the very obvious, in clinical work, in the deadhouse, and in the laboratory. There has been neither time nor opportunity for the study of the subtleties of pathology, and it is here

that the milder grades of mental disorders belong. The teachers of medicine have not been alive to the necessity for recognizing the bearings of disorders of this type. Conditions of modern life have favored the multiplication and spread of these disorders, and the medical schools have not met the situation so arising. The result is the extensive movements to embrace mystical methods that appeal to the dramatic sense and are not devoid of individual sympathy. In many cases the converts to these methods have turned away from the churches to which they have belonged, and from which they have got as little satisfaction for their personal needs as from their physicians.

Although the originators of the Emmanuel Church movement claim that their methods are not in imitation of those used by the Christian Scientists, it would be difficult for them to convince the latter that they have not been borrowers in many essential respects. Both make a powerful appeal to the mystical side of man's nature and both make the teachings of Jesus a fundamental feature of their cult. Consciously or unconsciously, both make use of the influence of suggestive therapeutics, although in most instances they do not resort to the use of hypnotic sleep. Both again appeal to similar mental types, to persons influenced by emotion or imagination uncorrected by objective methods and strict reasoning. The minds that fall under the control of these cults are commonly mediocre or inferior,

and when brilliant or cultivated, seldom possess creative power or logical quality. Many of the devotees of Christian Science and of the Emmanuel Church movement are discouraged and exhausted by disease. They welcome relief from the unsuccessful effort to think clearly about their troubles, and freely surrender themselves to the mental control of those who assert a narrow and intense faith in ideas and procedures that are out of the ordinary. A sharp analysis by the subjects of the methods used would be fatal to even a very moderate degree of success, for that would be destructive of delusion and suggestion. It is for this reason that persons who have been trained in the methods of experimental science, or are in the habit of tracing the relation between cause and effect, seldom fall under the spell of procedures of this nature. An impersonal attitude towards things and the ability to see the wonders of the world in commonplace unfits man and woman to yield to such influences. On the other hand, those who wish to be made much of personally, who desire that their troubles should be given importance, and who, seeing nothing in the ordinary, are in search of sensations, are most likely to prove satisfactory patients.

Despite these common features, it would be unfair to further identify the Emmanuel Church movement with that of the Christian Scientists. In the absurdities of their doctrines and in their disregard for the facts of nature and of human history, the Christian

Scientists stand alone among the sects that have won material and propagandist successes among Anglo-Saxon people. Consistent in their belief that the control of the mind over the body is absolute, they ignore the existence of well-defined and even irremediable disease. The undoubted successes which they gain in hysterical affections and in some structural diseases in which symptoms have been exaggerated by coexisting nervous disorders are balanced by numerous criminal failures with organic disease which might have been benefited by suitable scientific medical or surgical methods, and by innumerable relapses in cases where the nervous factor has been unimportant as compared with the definite existing nutritional disease. The establishment of so pretentious, ignorant, and dangerous a sect is possible only in a country in which biological culture is low, and the people are ready to be bamboozled by every kind of political, sociological, and medical charlatanry.

The Emmanuel Church movement represents far less dangerous and pretentious tendencies, though many of its assumptions are unscientific and anti-biological. Many of its doctrines are vague; it fails to recognize the difficulty of distinguishing between functional and organic disease; it invokes the unproved claims of telepathy in order to explain the effect of prayer on the mind of God, and it assumes that the "subconscious mind" (or sub-attentive consciousness) "has more direct control

of our physical processes than the conscious" and "is purer, more sensitive to good and evil than our conscious mind." It is, perhaps, not surprising that doctrines like these should be taught by clergymen who have come under the antirational spell of influential teachers who, like Professor William James, contend that the mystical visions and orisons of a neurotic of the St. Theresa type can safely be regarded as authoritative (at least for the subject herself) and as representing a state of consciousness that may permit a union with God. The circumstance that the Emmanuel sect refuses to treat patients who have not also the examination and advice of a physician does not relieve it of the charge of purchasing its influence over the minds and bodies of men at the expense of that clear thinking, and that resolute facing of unwelcome facts, which is essential to the formation of real human character. Doubtless, it is well that the physician should know more of the problems of the clergyman, and that the clergyman should inform himself better as to the aims and methods of medical science. But the functions of clergyman and physician cannot be fused successfully, and the attempt to do so is in opposition to the uncheckable tendency to the differentiation of professions. The cure of mental and nervous diseases is the function of the physician, and if he is but imperfectly prepared for his task, he must learn to perform it better. Such therapeutic suggestion as may be required should come from

the physician, and should be planned by him in its relation to the physical and mental needs of the patient. There are many patients with nervous affections who are weaklings or degenerates, who cannot be permanently helped by any methods, however rational or mystical and God-communing. The best that can here be done by society is to turn its attention to prevent the creation of this pitiable type of humanity by teaching people to control the causes that lead to it—and this, again, is the task of the physician.

CHAPTER VII

DEATH AND IMMORTALITY

Only occasionally have the egotism and self-confidence of man risen to such heights that he has dared to believe in an earthly immortality for himself, as in the case of Louis XIV. To the majority of mankind the termination of life, though often anticipated with some degree of dread, appears as an entirely normal incident. In the period of active growth the mind gives little heed to the thought of death, and it is only in the period of decline, in the second half of life, that there is a tendency to revert to the idea of death or to dwell upon it. Temperament and the bodily sensations have much to do with the extent to which the mind dwells on the thought of dissolution. The robust man, engaged in affairs, is apt to think of death only in so far as its possibility necessitates practical measures, but the man of sensibility and ideas early becomes interested in death as a phenomenon, and his interest is liable to be heightened to a peace-disturbing degree in the event of the consciousness of self being heightened through that form of ill health which sensitizes the nervous system to all kinds of unpleasant impressions. The conception of death which is formed in

different types of minds varies rather widely in definiteness, in fearfulness, and in general verisimilitude. It is unlikely that the conception is ever more than a rough approximation to the truth, even in the mind endowed with insight and education. For the mystery of death is profound, being, as it is, the pendant to the mystery of life. An alteration which leaves the body unaltered in form, and without obvious structural change while depriving it and its constituent parts of their functions, must always excite in the highest degree the interest of the thoughtful intelligence, and cause it to seek a deeper understanding of its essential meaning. Inscrutable as biological science must still admit the death mystery to be, it can, nevertheless, throw out some hints that may operate as a corrective for certain gross errors that are widely prevalent.

When the circulation of the blood ceases within the body of a human being, he is pronounced to be dead, and the fact that he never comes to life again under these circumstances leaves no room for us to doubt that death has indeed come. Yet the situation is not so simple as might at first sight appear to be the case. The body is made of various tissues, and the cessation of the circulation does not have the same effect on all. The nervous system is peculiarly sensitive to the withdrawal of its blood supply, which is quickly followed by the appearance of an acid reaction and permanent alterations in the protoplasm which are incompatible with the restoration

of consciousness — that most refined and subtle of all bodily functions. Other structures stand in a very different relation to the withdrawal of the blood supply. It is true that they suffer change from this deprivation and that they tend to undergo that solution in their own juices which physiologists call autolysis. But, if within a short time after the cessation of the supply of oxygen-laden blood this supply be restored, there is a return of functional activity. Thus the liver can be caused, by perfusion with blood, to secrete bile, and the kidney to make urine. Dr. Carrel preserved a human artery in cold brine for thirty-five days, and found it to be entirely functional at the end of this time, and able to replace permanently an artery which had been removed from a dog. And many years ago Professor Newell Martin isolated the heart of a dog from the body and placed it under conditions which permitted it to beat regularly for many hours. From these facts it is clear that death, in the ordinary sense, does not mean the coincident death of all parts of the body, but is compatible with the survival, and even the long survival, of certain kinds of cells. So when we see before us a human being who has just drawn his last breath, we know that in a technical sense death has not occurred in all parts of his body, because in certain parts there remains, for a time, the possibility of rehabilitation of function.

This inequality in the fate of different tissues deprived of their supply of blood and oxygen leads

to some singular paradoxes. Dr. Crile cut off the head of a dog, but so quickly reëstablished the blood supply in the trunk and extremities that these continued to live and functionate for twenty-four hours. A corresponding restoration of function in the brain by similar methods has not been accomplished and appears impossible. What shall we say of Dr. Crile's decapitated dog? Was he alive or dead after decapitation? The answer must depend upon our conception of death. If we attach great weight to the life of the less noble tissues, the dog must be regarded as being alive despite the loss of the head. On the other hand, if we attach supreme importance to the brain, to the function of consciousness, and to the all-important part it plays in making personality, we must answer that the dog was dead despite the fact that the body was alive. This is equivalent to conceding that personality is what determines life. The fact that, in the experimental case just cited, the personality in question is only that of a dog does not alter the case; for there is little doubt that the illustration of the dog could be successfully repeated in the case of man.

If we admit that the life of the brain is the essential feature of human life, we have to make some further admissions based on the dissociation of function analogous to that just noted in the case of the dog. We have to admit that, however well the body may otherwise be preserved, any changes in the brain that tend to degrade personality are changes

in the direction of death. The subject of paralytic dementia, for example, must be regarded as essentially dead, since those structures have been hopelessly destroyed which subserve intelligence, the finer emotions, and the moral sense. The body may otherwise have few physical defects, and may hold in its cells the potential that would suffice to maintain it for years, but this bodily health in no wise alters the fact of the intrinsically mortal decadence. On the contrary, it serves to emphasize the antithesis between body and soul. But if we concede soundness to this position, we are forced a step farther. We are compelled to regard every insult to the nobler structures of the brain as being, in a singularly real and intimate sense, a limitation of life and a step, if only a small one, toward actual dissolution. Every alcoholic debauch, every intoxication that benumbs the cortical functions of the brain, must be interpreted in the light of the supremacy of the cerebrum in the determination of what is truly vital.

II

This dependence of personality on the integrity of the cortical structures is the most convincing evidence that thought is a function of the brain. Probably there is nobody who, knowing the evidence, would be disposed to deny that disease of the brain is the direct cause of degradation of thought and personality, and that death of the brain causes cessation of thought. But there are very many who

believe that death of the brain does not put an end to human personality. They believe that human personality, though residing in the brain, is not limited to its residence there, and that after death it continues to have an existence independent of the body. They believe, in fact, in human immortality. And those who hold this belief are so numerous and number so many persons of high intelligence and character and distinction that the belief has been accepted by thousands of followers of less intelligence, as a necessary part of their faith in things and forces inaccessible to the senses. If questioned about their faith in human immortality, the most intelligent of these persons will admit that there is no proof for their belief from ordinary rational evidence, but, at the same time, they will insist that there are intuitions which are superior to such proofs and that these intuitions must be heeded. They will contend that immortality is one of the great spiritual needs of man, that it is, in some form, an apparently innate belief with most persons, and that such innate beliefs carry with them a strong presumption in favor of their correctness. They will also urge the elevating power of the belief in immortality. And from these considerations they reach the conclusion that the immortality of the soul, if not proven, is sufficiently probable to constitute a legitimate article of faith. There are others who go somewhat farther. They are convinced that it is possible for some minds to be placed in communication with the

spirits of the dead, and the apparent manifestations of these spirits are regarded by them as satisfactory evidence of another phase of existence of the human soul.

It has long been self-evident that the question of the possible preservation of human personality after bodily death is not a question suited to the methods and aims of science. In order to establish the truth of an alleged experience or occurrence, it is necessary that the phenomenon in question should be accessible to the experience of more than one person. A person may have a sensation which he describes as that of his heart being grasped by a hand, and may even become convinced that this sensation is evidence of the fact that it is actually being so grasped. But, however strong his conviction be, he cannot establish it on a scientific basis. To establish his contention, he would be compelled to make a suitable appeal to the senses of one or more trained persons who had the confidence of other trained persons. Repeated appeals of a definite nature, made under strictly controlled conditions, would be necessary to convince a jury of trained minds of the probability of the contention; and, in order that this faith in fact should not be overturned, it should be possible, from time to time, to repeat the demonstration, or one of a similar nature. Clearly such conditions are quite impossible to exact in dealing with the claims of communication between this world and a supposed spirit world. It would be unscientific to

deny the possibility of such communication. On the other hand, it has to be admitted that when the evidence of this communication has been purged of intentional or unintentional deception, there remains no evidence that a spirit world, capable of connection with living human beings, has any likelihood. The argument from the spirit world in favor of human immortality must, therefore, be dropped as invalid for the present, unless, indeed, we admit the existence of two kinds of truth, one derived from rational thought and experiences, and a second variety in which a thing becomes so because certain people strongly wish it to be so.

But if science cannot investigate the supposed spiritual or supernatural world, it can, at least, give us suggestions as to the probability of certain tenets on which the belief in human immortality is founded. What has biological experience to suggest in regard to the argument derived from the innate longing for immortality and the spiritual need for such a belief?

The view that belief in immortality is a spiritual need has its origin in a craving for a future life which is alleged to be of wide distribution, as well among primitive as among relatively civilized people. The desire in some persons takes the form of a wish for specific rewards for good conduct in this world, or in compensations for failures to enjoy material happiness. Persons of a more refined mold desire a future life mainly for the sake of meeting again

those they have loved. For the sake of discussion, it may be assumed that these desires are really very widespread, although there is some evidence that a considerable part of the population of Christianized countries is little or not at all concerned with such questions. It seems safe to believe that there is among those people who think at all a rough relationship between the wish for life in this world and life hereafter, in the sense that a strong desire for a future life is commonly associated with a strong attachment to this life. Persons whose grasp on life is weakened, as by disease, or by profound disappointment, are almost certain to experience a concomitant decline of interest in a future life. This parallelism is significant. It points, I think, to the grounding of the desire for a future life in the instinct of self-preservation. This instinct is fundamental and organic. It reflects in consciousness the property possessed by every living cell, which causes it to defy and to antagonize insults and injuries, great or small, which impinge upon it. The most hopeless melancholic or hypocondriac, inclined to suicidal thoughts and acts, will struggle vigorously to avoid drowning on suddenly falling into the water. And similarly we cling to life and dread to die, though decrepit and racked with pain. Mæcenas wrote:

> "Make me weake of hand,
> Scarce on my legges to stand,
> Shake my loose teeth with pain,
> 'Tis wele so life remain."

It would be a singular thing, indeed, if human beings, endowed with the deep-rooted instinct to live, should be able to think of death without aversion, and without a strong impulse to circumvent it. When it has once become obvious to a man or woman or child that death is inevitable, the mind invents a substitute for life, and this substitute is the hope or conviction that there is a personal hereafter.

In minds accustomed to weighing evidence with scientific impartiality, this belief tends to be neutralized by various considerations which render a future personal existence improbable. In the entire range of biological phenomena there is nothing to suggest that a continuation of life for any species is probable or necessary or desirable. The successive stages of development of pupa, chrysalis, and insect are sometimes cited as analogous to a stage of life in the world followed by a future life, but this suggestion is so remote that no thinking person can be influenced by it, except perhaps during a period of emotional disturbance in which the analytical faculties are benumbed. The science of life, as we know it to-day, points to an evolutionary process in man by which there is a slow change in human type towards one less brutal, less selfish, and more thoughtful of the interests of others. It is difficult to see why inferior types of life, including inferior human types, should be preserved indefinitely in any form. When they have lived, they have served their purpose, provided that they have left successors. An elab-

orate and wonderful mechanism has been provided to secure that reproduction which secures the preservation of the race under conditions of variation that favor an improvement in type. Sentiment suggests that there would be a certain fitness in the continuity of the lives of a few great men of lofty character, such as Christ and Abraham Lincoln, but observation has taught us that nature's processes respect the race but not the individual, and that in this most democratic of all systems there are no exceptions. In the sex instinct nature gives the individual a powerful incentive to perpetuate his or her personality in a modified form, and if there is a failure to utilize this chance, the gap is filled by other progeny of those who do utilize it, and the possible new beings are not missed.

History teaches also that while religious faith has often proved a stimulus to good acts, a belief in a future personal life has often operated as a salve for bad acts. There are many persons who have eased their consciences by giving alms calculated to secure the safety of the soul in another world. On the whole, it is an open question whether a belief in a future life has done more good by deterring persons from evil through fear of punishment, or more harm by giving questionable motives for conduct in general. It seems of the first importance for the growth of good morals that people should be prepared to face in this world the consequence of their acts here. The gradual replacement of the belief in a

future life by an intelligent rationalistic conception of conduct based on natural laws is a change which appears to me inevitable and greatly to be desired. In the present state of science it would be an error to teach that a future life is impossible, but I cannot see that it would be a mistake to teach that such an idea is without support in biological experience.

I should like to observe the effects of teaching intelligent children, susceptible to culture, that a belief in personal immortality appears unreasonable and unnecessary in the light of science, and that such a belief is not improbably a refined and wholly natural form of egotism based on the insistent obtrusiveness of the instinct of self-preservation. For I am disposed to believe that this teaching, which cuts off the prospect of heavenly rewards and hellish punishments, would lead to a greater considerateness in all human relations by forcing people to understand and accept the natural, instead of pursuing the supernatural. For example, it is a notorious fact that parents neglect their children in a great variety of ways at the same time that they are greatly pained at the thought that death may permanently separate them from their children. Would not the practical results be better if, being taught to feel that a permanent separation is natural and inevitable, they should drop sentiment founded on a dubious belief, and seriously give themselves to the task of helping their offspring, with the utmost earnestness and, if necessary, with self-sacrificial efforts? I

am unable to see that this negative teaching would destroy any chances of a future life, supposing that science is mistaken in its indications, as it is conceivable that it may be. Conclusions regarding the probability or improbability of a future life should be drawn from all the facts of science and human experience, and we should be prepared for accessions to scientific knowledge which will render belief in personal immortality more probable, or perhaps even less probable, than it now appears.

BOOK III. THE SEX INSTINCT

CHAPTER VIII

SEX AND THE INDIVIDUAL

The sex instinct is the only human instinct that can be compared with the instinct of self-preservation in respect to the profundity of its influence on the conduct of man. In its grosser expressions this instinct differs from that of self-preservation in one extremely important way, — that is, in being only occasionally instead of continuously operative. In its secondary manifestations, however, it may uninterruptedly color consciousness, its effects being often fused with those that spring from the instinct of self-preservation. It is essential not to lose sight of this fact in any analysis of human conduct from the standpoint of biological laws, for there is a strong tendency among people, even among the cultivated, to ignore the rôle of the sex instinct in common life. Sometimes this arises from true ignorance or self-deception, sometimes from hypocrisy, but in every case it is fraught with danger — the danger which comes from dealing in a superficial manner with a powerful force whose play cannot be evaded.

I

The striking fact that all the higher animals multiply through the union of cells coming from two distinct sexes is in contrast to the fact that the lowest forms of life multiply by much more direct and simple means, such as budding or fission. This contrast in methods and their results in itself suggests that the relatively complex sexual means of reproduction are, in some way, necessary to yield the highest types of animal development, and such an inference is well borne out by facts. It is almost self-evident that the fusion of male and female cells serves the purpose of bringing together in one organism a far wider range of hereditary possibilities than would be possible with any simpler system of reproduction. It is an interesting circumstance that some degenerating species of animals, such as barnacles, exhibit exceptional complexity in the reproductive processes. The reason for this complexity appears to lie in the fact that the animals in question have very many eggs of extremely small size, thus calling for special and complex reproductive mechanisms for their disposal. Instances of this sort in no wise invalidate the general statement that the change from the simpler methods of reproduction to the more complex forms of sexual reproduction mark an advance essential to the evolution of progressively higher types of animal mechanism.

The process of fertilization is one of *rejuvenation* of

the egg cell. In some lower forms of life it has been found by experimental biologists that the egg may be stimulated to at least partial developmental changes without action of the male sexual cell. Thus Professor Loeb found that the egg of the sea urchin develops into a larva when treated with certain inorganic salts, in suitable concentration, although here it cannot be claimed that these salts contribute to the new being the hereditary qualities which would have been given by the male cell. But it is an open question whether the human egg cell is capable of being stimulated to develop, even partially, by means of any chemical agents which are not laden with the materials that carry hereditary traits.

In man, as in all complex animal organisms, there is a highly notable contrast between the cells in process of active development and those that have matured. An animal cell consists of two clearly separated portions which have very different chemical compositions and biological properties — the centrally located portion known as the nucleus and the surrounding mass of material which makes up a large and often preponderant part of the cell — the cell body or protoplasm. What takes place in the cell body is largely controlled and directed by the cell nucleus, and damage to the nucleus compromises the life of the entire cell, whereas the cell body may be injured without necessarily affecting the integrity of the nucleus. When the egg cell of a higher animal

is impregnated by the sperm cell, the cell undergoes a remarkable change, in which the nucleus is stimulated to new activity and to the process of division which results in the formation of two cells. This division marks the beginning of the embryo. In the cell divisions that now follow in rapid succession it is the nuclei that are especially prominent, both because the divisions (or mitoses, as they are technically called) have their starting point in the nuclei and because the nuclear substance is now very abundant as compared with the surrounding protoplasm. The dominance of the nuclear substance during growth is a characteristic of this period of life. Gradually, as the rapidity of cell division diminishes and growth becomes less, the cell nucleus comes to form a small part of the entire cell, and when maturity is reached and cell division is rare, it is the cell protoplasm that dominates. Hence, it appears that this period of development is the period of nuclear dominance and activity, while the period of maturity is one of lesser or altered nuclear active and reactive dominance of the cell protoplasm. The important thing to realize here is that the adult cells, in the course of their development and differentiation, have largely surrendered their powers of reproduction. New powers are, however, acquired by these adult cells. The youthful and aggressive reproductive functions of the young cells have been exchanged for the more stable, more diversified, and more elaborately coördinated functions of the

adult cells. This is true, at least, in the case of some of the tissues.

Thus the developed human body consists of myriads of cells that have lost, in a greater or less degree, their powers of reproduction (though this is partially maintained by some kinds of cells). There is nothing to indicate that this power of reproduction can be restored to them. This means that, after a time, death is inevitable. In each sex, however, a relatively small number of cells have been set aside that, by some wholly inscrutable mechanism, are laden with hereditary qualities or memories. The individual germ cells (at least in the case of the female), like the somatic cells derived from the parent germ cells, have undergone some development. But this slight development, be it noted, has not been attended by an expenditure of the powers of reproduction. These cells, therefore, still possess their specific reproductive powers, though these lie latent unless impregnation occurs. The germ cells of both sexes hold stores of energy that may be likened roughly to the potential forces exerted by rivers that have been dammed back. It is the destiny of the incomparably greater number of the germ cells never to have their stored energy released in reproduction. Yet for a relatively few female germ cells the restraining barriers are torn away by the energy contributed to them by the heads of the male germ cells or spermatozoa. The junction of the male cell with the female cell is like the acces-

sion of a new river to that which has been dammed. The force liberated by their conjunction is sufficient to tear away all barriers, and from the instant of this release their mingled forces rush on, with gradually slackening energy, to the fulfillment of their destiny.

The process of fructification of the female by the male cell is thus in its essence a stimulus to development in which new possibilities of developmental variety are rendered possible by the fusion of two streams of hereditary qualities. So sexual reproduction, by virtue of this fusion of diverse forces, makes possible new and elaborate types of beings that are not imaginable under any observed system of unisexual reproduction. In unisexual organisms, as, for example, the paramecium, there is a sort of theoretical immortality, for as each organism divides by budding, there can be no death so long as some representative of the type exists, but this form of immortality clearly involves a lack of individuality. Moreover, under such a system, only trivial variations appear, in general, possible, and hence the path of organic progress is fatally barred. Indeed, even the continuation of the budding process appears to be limited to some hundreds of generations, unless occasional contacts occur (perhaps foreshadowing vaguely a sexual union) with members of another family, in the course of which contacts there is a streaming of protoplasm from one cell into another. Indeed, an actual fusion of cells may occur in which there takes place an exchange of nuclei. Even in

these lowly forms, therefore, rejuvenation depends on the stimulating properties of cell substances of somewhat different strains.

The sex in which impregnation occurs is, apparently, by necessity of economy and convenience, the sex on which devolves the task of nourishing the young organism — although it is quite within the limits of possibility that an embryo may attach itself and grow within suitably prepared male structures. In nature there are, in fact, a few examples — though only among the somewhat lowly forms — of male gallantry in at least sheltering the embryo. For example, the male pipefish and sea spiders are provided with blind pouches in which they house the eggs during development. But, in general, the duty of nourishing the embryo involves noteworthy personal sacrifices and discomforts on the part of the female parent, often including, for the human mother, a limitation of muscular and intellectual activities. In the case of the human species, moreover, there must be reckoned also the relatively difficult and painful process of delivery. This mechanical difficulty in childbirth is due to the large size of the child's head, which is merely another way of saying that it is the inevitable result of the long period of growth and protection of the noblest part of the physical mechanism, the cerebrum.

The period of early adult life is, in general, the time when persons are physically best fitted for the responsibilities of parenthood. Yet it may be said

confidently, that of the women who have borne children there are very many who would not deliberately have encouraged the process of impregnation, and would, indeed, have evaded it but for the fact that this process is accomplished through the mediation of that varying mixture of sensual excitation and emotional fervor which is known as the sexual appetite. Without this, there would be relatively little inducement to suffer the physical discomfort, the mental perturbation, and the actual bodily risks that intervene between conception and the birth of a child. The sexual instinct, at times so peremptory and so powerfully engrossing, is thus nature's device for entrapping the unwary to perpetuate their lives. But this crude statement tells only a part of the truth, for among cultured races sentiment and affection are so closely entwined with the sensual aspect of the sexual instinct that the latter finds innumerable expressions which give few or no obtrusive hints of their origin and association.

II

It is not surprising that an instinct so imperious should often be misused. Emerson said, "The preservation of the species was a point of such necessity that Nature has secured it at all hazards by immensely overloading the passions, at the risk of perpetual crime and disorder." The indulgence of sexual passion involves a temporary loss of habitual

restraint which makes its expression in the highest degree automatic and no longer under the control of the cerebral centers. The effects of misuse are singularly far-reaching. Whereas abuses of the food appetite usually work their evil consequences on the body of the transgressor, sexual abuses tend to implicate innocent persons also. The ills that arise in this way are of many kinds, and are both grossly physical and more refinedly physical or spiritual. They have brought to mankind, and still bring to it, countless and unpicturable miseries, and there is now no reason to think that they will not continue to do so for centuries to come. The disabilities, sufferings, and premature deaths that follow in the wake of venereal diseases are horrors of human life that must, at times, cause the stoutest hearts to falter in their belief in human nature. The most diabolical and revolting features of these infections is their incidence in women and children who are wholly innocent. And even where self-indulgence is not followed by infectious disease, there may still arise disorders of body and of mind that bring serious losses of energy, and that fill asylums and hospitals with human wrecks.

Such is the price that the human race pays to secure its own continuance. Yet this heavy tribute in suffering and death cannot be said to be exacted by nature. These dire losses are almost wholly preventable, and it is even likely that within highly

disciplined social groups, they will one day be very largely prevented. An intelligent self-discipline is all that is necessary to bring about a result of such incalculable value to the race. What human beings need more than all else is discipline and control over their faculties, and whatever makes for this makes for civilization. But in the case of the passion whose gratification is an automatic and frenzied act, the reassertion of cortical control is very difficult when this control has become enfeebled or lost. And this is particularly true of imaginative and highly sensuous temperaments. The cortical control essential to avoid evil consequences does not come necessarily nor merely from knowledge. It is notorious that a conventional and superficial familiarity with physiology in itself brings no accession of sexual morality, but it is on the contrary liable to inspire contempt for the instinctive self-restraint often practiced by the uninformed. What is especially needed is the will to practice sufficient self-restraint to avoid incurring the risk of bringing evil consequences to others, and this obviously depends mainly upon good feeling and a realization that the sex instinct should serve a far more serious purpose than mere sensual gratification.

There is one road by which, more surely than by any other, human beings can attain to a higher level of sexual morality. This is through a betterment in the attitude of women toward the ideals — or lack of ideals — harbored by men. As the sex

instinct is more assertive in men than in women, it has become an accepted social usage that the male should make the proposition of marriage — a usage springing wholly from biological conditions. This custom makes it possible for women to exact certain conditions for the acceptance of their husbands, and of such conditions there can be none more important than a clean sexual record. This is a matter in which parents could play a decisive and extremely helpful part, if they possessed the necessary courage and foresight to guard their daughters against the pitiable consequences of marriage to men whose past histories make them dangerous either as carriers of disease or as incontinent and loose-lived mates. That parents who are otherwise conscientious in the discharge of their obligations toward their children should so frequently fail in respect to a duty so far-reaching and critical as this can be explained only on the ground that they shrink from making an unconventional inquiry or are reprehensibly ignorant of the possibilities. The discovery of a sexual flaw in the history of a suitor would not necessarily mean his rejection, but it would mean that the risks attending marriage had been weighed, and that subsequent physical miseries and other disappointments would not befall as surprises, as is now too often the case. There are not lacking indications that women will, in the future, avail themselves of their undoubted power to set a higher standard of sexual morality for men than exists at present,

and it is only reasonable to think that this improvement will come mainly as a special phase of that more general amelioration of the relation between the sexes which is an outcome of the growing wish of people to make better and better use of their faculties.

III

The attitude of the male and the female toward the sexual impulse is, in general, dissimilar in one important respect. The male seeks sexual gratification without giving much thought as to progeny, certainly with no strong desire, as a rule, to have children. In women there is often a distinct wish to have children, which paves the way for the multitudinous personal sacrifices which maternity imposes. But there are also women who care little to have children, or to whom the idea of maternity is repellent. If such women are sensual and uncontrolled by elevating influences of education or religious precept, they constitute material from which the prostitute class may be recruited. What is called respectable society holds thousands of women who have the sensual, pleasure-loving temperament of the prostitute, but who never become professionals because they are protected by fortune from the necessity of making a living. They marry and have children, but this does not radically alter their natures, and they show, during their entire lives, so strong a tendency to self-gratification in one way or another that they

have no hesitancy in neglecting the interests of their children wherever these conflict with their own pleasure.

The life of a prostitute almost inevitably leads to a progressive spiritual and bodily decline, which is significant to the community wherever the number of such persons is large. The causes of this decline are not elusive but self-evident. Where physical degeneration is not induced by specific infectious diseases, it almost certainly is caused by the nervous exhaustion that attends the excesses that are part of the life of prostitution. For the spiritual degeneration there is a twofold reason. Prostitution involves the systematic perversion of a powerful natural instinct, and thus sets itself in direct antagonism to the operation of the forces of nature. Whereas the true object of sexual relations is to produce children, the object of the prostitute is to use every means to circumvent this legitimate end. The final result of this persistence in an unnatural course is a depressive consciousness of failure, which even those of mediocre intelligence cannot escape. In this respect the degenerating effects of prostitutional misuse of the sex instinct are the same as those of misuse unconnected with prostitution. But a second powerful element enters into the spiritual breakdown of the prostitute. This is the acceptance of money (or some material equivalent) as a reward or compensation for misuse of a fundamental instinct. When dictated by impulse, the misuse of

the sex instinct, however regrettable, is something that may at any time be checked by growing intelligence and improved self-control. The necessity for the acceptance of money cuts off this possibility of restraint and operates as a fixative for a dangerous habit of life. It also has the effect of rendering the expenditures of sex energy a deliberate act rather than one of impulse, which is only pardonable where its object is the production of children. These conditions lead to a loss of self-respect, which can but reënforce the depressing effects of the perversion of instinct. Thus is accelerated the spiritual degradation of the habitual prostitute.

Prostitution is a practice of such antiquity that its abolition appears hopeless. In consequence of this humanity has grown to accept it with little question, as if it were but a part of the inevitable. The attention given to it has for its chief purpose the control of the evils that result from venereal disease, and some progress has been made in the direction of protecting the community from such disease. A moderately efficient aid in this direction is the licensing of professional prostitutes by the state, the right to practice this calling being revoked from those women who develop disease. But this method involves the official recognition of prostitution by the state, as in Germany and France. Anglo-Saxon countries have hesitated to follow this plan, partly because state recognition is far from being a thoroughly effective means of limiting disease, partly

because English-speaking peoples hesitate to give to an evil practice the color of indorsement that comes from state recognition. Such indorsement of the system has, at least, the appearance of tending to fix and perpetuate it, and the objection to it is therefore well founded. It is entirely consistent that this attitude of mind should be dominant in those countries in which the position of women is highest, and the respect for feminine qualities the greatest. Moreover, it is an open question whether the physical protection of society that comes from public examination and inspection cannot equally well be obtained by teaching prostitutes in their own interest to seek competent medical attention.

It has lately been suggested, especially in Europe, that persons seeking to marry should be compelled to obtain a certificate of health as a prenuptial sanitary guarantee. Such a practice so outrages the sense of personal privacy that it is not likely to be adopted by Anglo-Saxon races, whatever measure of success it may have elsewhere.

None of these physical precautions touch the heart of the question of prostitution; they are directed toward making the system safe for men rather than toward its abolition; indeed, through rendering it comparatively safe the extension of prostitution is encouraged. But the tacit approval which society gives to prostitution and a double standard of morality is based on a wholly false assumption, namely, that illicit sexual relations are essential in

any society. Yet it is true that however powerful may be the sexual impulse, its illicit gratification is under no conditions essential to the health of man or woman. This impulse is doubtless difficult to control, and especially so in some persons, but though it can be learned only by years of intelligent education, self-control is as possible here as in any other direction. It is quite within the power of conscientious and intelligent parents to bring up their children in such a way as to screen them from premature and illicit sexual indulgence. But this is only possible where intelligence is sufficiently great to grasp the fundamental fact that to have good children is a profound privilege and not a burden, and that every practice which imperils this privilege is liable to lead to suffering and loss of personal self-respect. On the other hand, thoughtless production and thoughtless bringing up go hand in hand, and so long as it is the ideal of a nation to increase in numbers without reference to quality, no progress can be expected in the restriction of prostitution, because there will always be a large undisciplined class. It is, indeed, inconceivable that even the most advanced nations will not always contain a lower stratum so uncontrolled and unintelligent as to keep alive the practice of prostitution, but there is ground for hope that in time a much larger proportion of the population will prove ineligible for prostitution than is at present the case. Poverty is a factor in the case in so far as it favors

failure in education and self-control and dangerous propinquity of the youth of opposite sexes. The greatest of all checks to prostitution would result from the growth of that refinement of feeling and self-consciousness which would render clear to any man the intense and degrading selfishness that does not hesitate to damage the life of another individual for the sake of personal sensuous gratification, and this feeling will be the more strongly operative the greater the respect for the ties of family life and the greater the hope of those concerned in one day having children. But such changes as these could come only as part of a general elevation in the level of intelligence and moral sensitiveness.

IV

The sex instincts do not always lead in the direction of excess. Indeed, the opposite tendency not rarely asserts itself — that is an avoidance of all sexual relations in life. This may be due to a weakly developed sex instinct (sometimes dependent on poor health) or to the excessive distrust of a timid or cold nature, or to intense absorption in an occupation calling for a great output of mental or muscular energy. In each case the effect is the same; there is a failure on the part of the individual to reproduce. There are two great privileges which nature accords to every normal human being, — the privilege of self-development and the privilege of

having children. The failure to have children means a break in the continuity of a life chain made up of numberless links of germ plasma, derived from an incalculably extended past. The biological gravity of the break is profound — too profound to be immediately grasped by the imagination. For the first break in the life stream is also the final break and means the actual end of the long chain, the fatal surrender of all the rich and varied human possibilities that lie in the future. No degree of self-development, no personal satisfaction or pleasure, however intense, is a real compensation for the failure of a human being to avail himself of the privilege of perpetuating his own life stream by allowing it to mingle with that of a chosen life companion. Yet many a man of superior powers has sacrificed his line on the altar of wealth and social eminence. Francis Galton called attention to the destructive effect of the British Peerage on the continuity of families. Of English judges raised to the peerage for their ability, only a very few left families, despite the fact that the possession of a title was a powerful inducement to marry and transmit it. But the marriages were commonly made late in life with women of wealthy families and little reproductive power — the acquisition of a peerage requiring a considerable outlay of money to maintain conventional standards of dignity. The biological failure to continue the race — the only complete and irredeemable failure in life — may be glossed over by worldly success

or pleasure, or by the intellectual satisfactions that arise from concentration of effort, but it is unsusceptible of compensation. When the world once realizes this, it will teach its rising generations to safeguard jealously and deliberately the most precious and potent powers, instead of trifling with them.

Thus it happens that as a preponderance of the sex instinct over the instinct of self-preservation tends to the destruction of the individual, so the undue preponderance of the somatic instincts over the sex instinct leads to the fatal break in the racial line. Both fatalities are due to that imperfection in the balance of antagonistic (but also coöperative) forces which is the distinguishing feature of the normal, in body and in mind. Instinct tends to guard the individual against either of these fatalities. It makes him self-conscious and cautious or timid in entering on the exercise of the sex functions. By some disregard of the natural mentor (a disregard often fostered by education of an imperfect kind) man falls into the error of excess. On the other hand, the excessive inhibition of the sex impulse, or its undue feebleness as compared with the power of the instinct of self-preservation, may result in the extinction of a human line, and all that this implies. So it is clear that the best and most satisfying results in human destiny are likely to be found where the somatic instincts maintain a well-balanced relation to those of sexual origin — neither suppressing the latter nor unduly releasing them from inhibition.

V

The chief aim of the sex instinct is to beget children. But while mere production may satisfy this instinct in its elementary form, intelligence and the instinct of affection make two demands of an important kind as to the quality of the offspring and the conditions of its development. The desire to have healthy and well-formed children is universal among parents, and the presence of a malformation in any part of the body (as clubfoot or hair lip) excites regret or arouses commiseration or disgust. Similarly, the appearance of mental defects causes distress to all parents except those of the lowest order. Instinctively, then, there is a demand for a good heredity, bodily and mental. Parents are, however, wretchedly ignorant of the best ways of securing these good qualities in their offspring, and very few give any thought to such known laws of heredity as might, in a measure, guide them. Man looks with nice care to the pedigree of his dogs, horses, and cattle when he mates them, yet seldom considers in his marriage the possible influence of his selection upon his children. It is thinkable that people might err in marriage based too largely on calculating choice, and not enough on instinctive attraction, but it is clear that they could safely take more interest in trying to secure, not only better physical traits, but also better moral and intellectual ones.

The race would certainly be a great gainer if intelligent and deliberate selection for intellectual and moral qualities could be substituted for selection based largely on the attraction of mere beauty, wealth, or social rank.

In considering the effect of heredity on human offspring an important distinction has to be recognized — the distinction between true hereditary qualities that are impressed on the germ plasm and various kinds of damage inflicted on the germ plasm by injurious agents, such as poisons or effects arising from impairment in nutrition. It is well known that ordinary acquired characters are not transmitted to the offspring. For example, the circumstance that a father or mother has lost an arm or leg previously to the time of conception has no effect on the offspring; and, indeed, mutilations generally are without perceptible influence. Similarly, there is no evidence that if a man, by exercises (as rowing), greatly develops his biceps muscles, his child will have large biceps muscles. But while there is thus no specific transmission of such an acquired character, all influences that bring good physical development to the father or mother may bring a greater store of energy to the germ cells by improving their supply of nutriment by way of the blood stream. On the contrary, all conditions that enfeeble the body are liable to diminish the store of energy in the germ cells by decreasing their nutriment from the blood stream. It should be clear

that these are not examples of the transmission of specific acquired physical characters, but only of a general nutritional effect exerted through the food supplies of the blood.

Nor is there any evidence that acquired mental characters are transmitted. It is discouraging to think that children receive no benefit from the culture gained by their parents as the result of long-continued deliberate effort. It is not safe to say that the germ plasm cannot be influenced in any way through mental effort, but it is safe to say that there are at present no indications of such influence. A great many examples have been cited to prove that maternal impressions during pregnancy have had a definite effect on the offspring, but none of these can be said to be good evidence for an affect exerted through the nervous system of the mother. It seems that the germ cells are not influenced in recognizable ways by the action of the nervous system of the parents. The realization that this is so tends to emphasize a fatalistic attitude toward life. If a parent can transmit only those qualities to his offspring that have been predetermined in his germ plasma, there appears to be little inducement to self-betterment in so far as it may affect the offspring favorably.

But a fatalism so grounded is no legitimate cause for discouragement. The fact that we cannot detect in the offspring any results of acquired mental characters is not positive proof that no effect whatever is

exerted, since it is true that the criteria of judgment on this point are, as already indicated, by no means simple or convincing. The question of such transmission must, therefore, be left open. There is, however, one salient fact of biology that renders a blind and hopeless fatalistic standpoint an untenable one. Admitting it to be true that the parent cannot improve the hereditary quality of the germ cells which he holds in trust for his line and for the race, it is nevertheless true that the conduct of the parent may detrimentally influence the germ plasm so as to lower the maximal possibilities of good for the offspring. The germ cells are sensitive to poisons, and may be poisoned in a variety of ways by the blood stream of the parent. This is true of both the male and female cells. The excessive use of alcohol, the poisons of syphilis and of malaria, the poisonous action of lead, are all examples of agencies that may greatly harm the germ cells and the beings to which they are destined to contribute. The damaging effect may be so great as to kill the germ plasm. Then there is sterility. Or the effect of the poison may not be so severe as to kill the germ plasm, but may damage it in obscure ways that lead to physical and mental underdevelopment, or to some well-defined disturbances, as epilepsy, or insanity, or a generally unstable nervous system. There are many other poisons that injuriously affect the germ plasm — as the chronic poisoning in kidney disease, in gout, and in diabetes, or in tuberculosis. The exact

effects of such poisons on the offspring cannot be predicted with accuracy. It is sufficient to realize that they each are able to depress the powers of the new life, and thus to place the new human being at a disadvantage in the struggle for existence.

It was previously thought that these injuries inflicted on the germ cells were examples of the transmission of acquired character, and even Herbert Spencer fell into this error. Nothing is now more clear than that these are simply the direct effect of poisons and have nothing to do with true heredity.

Finally it is well to realize that the growing embryo within the womb of the mother is subject to similar damage from poisons or injurious bacteria that enter the maternal blood. The germ cells of both father and mother may have escaped all injurious influences, only to fall a prey after impregnation to poisons developed in the mother after pregnancy has set in.

The practical inferences from these facts are very simple. Neither parent is responsible for the hereditary qualities which belong to the germ plasma. The maximal possibilities, physical, moral, and mental, of the children are wholly determined by the nature of the qualities of the germ cells that fuse to begin the new life. By intelligent and conscientious living the parents may hope to maintain in a high state of nutrition the germ cells which they hold in trust, and so to guard for their child the energies inherent in the cells which make up its body. But

any lapse in good habits of living, or any accident which subjects the parents to the poisonous effects of disease, becomes a hazard to the next generation, and may place on it a mortgage of physical debility or mental defect which can never be paid off. Therefore, so to live as to secure for children, unimpaired, the heritage which nature has made possible for them should be accounted a prime virtue. On the other hand, so to live, either through ignorance or self-indulgence, as to betray the precious life trust reposed by nature in every healthy man and woman is always a profound misfortune and frequently, also, a crime against humanity.

CHAPTER IX

SEX AND SOCIAL RELATIONS

In the social relations between the two sexes there is much to be criticized from a philosophical standpoint, and much room for improvement in the direction of greater considerateness, sincerity, and naturalness. In primitive communities the relations between male and female are apt to be free, and this freedom too often degenerates into license and the evils attendant on sexual immorality. These evils have so impressed some of the hardier and more self-controlled races as to lead them to make and enforce severe laws against illicit sexual relations, as in the case of the ancient Teutons. In all times women have been prized in large degree as a means of gratifying sexual impulses in men, and among many races they have been scorned as companions, and allowed little opportunity for personal development. Under such conditions there has always been a tendency to guard women jealously. This tendency is well marked to-day among Mohammedans and among the Spanish, but it exists, in some degree, among all European nations. Whenever girls and women are jealously watched and shut off from free communication with men, the precautions are trace-

able to a low standard of sexual morality among the men. In England and in the United States, where women are in a larger degree the companions of men, a better standard of sexual morality prevails and the sexes mix freely and with little suspicion of danger. This freedom of relationship between men and women is most highly developed in the United States. It is rendered possible by the relatively high standards of sexual life existing here among the men. And this freedom can exist with safety only where men and women have sympathies and interests in which gross sexual ideas have little or no part.

But even in the United States many restrictions exist on the social relations between the sexes, which might advantageously be relaxed, and doubtless will be relaxed, when people have developed more self-control and greater thoughtfulness. Among well-intentioned people the real dangers of sexual license are often so greatly feared as to make them timid and excessively guarded in their social relations with persons of opposite sex. This has the effect of greatly restricting the broader educational influence of free, sympathetic, and intelligent intercourse between persons of opposite sex — a factor in human development powerful for good and relatively unutilized as yet.

These restrictive effects are seen especially among married people. The idea is generally prevalent that when two persons have once been linked by the bonds of matrimony, they must wholly satisfy each

other's needs in all directions. This is a strongly antibiological notion which cannot stand close scrutiny. It is true, that it often happens among people of limited interests and intelligence, who are mainly occupied with getting the means of subsistence, that the marriage relation is regarded in a matter-of-fact way and its perfection is never challenged. If the couple be true to one another in the limited physical sense, if the father makes the necessary gains to support his family, and the mother faithfully tends her children, we have the picture of commonplace bourgeois happiness and contentment. But this happiness is really less secure than it appears, for it is in danger from the invasion of new human interests into the minds of either parent. And when such invasion occurs, it frequently breeds trouble, because neither party to the marriage contract understands the situation. One partner, or both, fails to recognize the naturalness and legitimacy of the new and intrusive human interest and, therefore, tends to act without full sincerity. The result is usually either an unnatural stultifying and absurd retreat from new human interests, or a lack of sympathy and understanding between man and wife, which lead to dissension or coldness and, too often, to the vulgarities of divorce.

The essential truth as to human marriage is simple enough. Man is naturally an imperfectly monogamous animal. Woman is conversely mildly polyandrous in tendency, but this inclination is power-

fully modified by the interests and care of the family. It is wholly out of accord with the primitive and acquired tendencies of man that one human male should, in all respects, satisfy the needs of a human female; and the converse of this is also true. Each human being is so complex in mental, moral, and emotional make-up that no one nature can be sufficiently rich to recognize, meet, and call forth all that is best in another, whether this other being is of the same or the opposite sex. So long as harsh circumstances of life suppress development, a man or woman may be blinded to his or her spiritual needs. But when there is leisure for thought and opportunity for a multiplying of human contacts, the limitations of the life mate must become apparent to any honest mind, dimly at first, sooner or later more plainly. So it happens that every intelligent and well-endowed man requires the friendship and stimulus of more than one woman, and every intelligent and well-endowed woman requires the friendship and stimulus of more than one man. If spiritual and physical charm enter into the attraction of such friendship, this is well, for the sentiment that is born of charm is a strong developmental and civilizing force. Marriages are the result of accidental propinquity. It is a pretty sentiment that such accidents have brought together two persons who are exactly fitted for each other, and that no other choice could have been possible. But it is an idea for children and not for men and women, and it carries with it a

danger to happiness because it runs counter to the facts of life.

It is shocking to the conventionally minded to realize that a sexual element may enter into an otherwise platonic friendship between one member of a married couple and an outsider of opposite sex. But let us not deceive ourselves on this vital point. The history of human marriage plainly shows that the relative considerateness now shown by men of the highest civilization toward women, in respect to their desire for sexual faithfulness, is a late development and, therefore, one that is easily lost. The motives that have led to monogamy belong in two distinct groups, motives based on ordinary self-interest and motives based on a refined form of altruistic feeling. Monogamy appears to have been one of the most primitive forms of marriage, but it may be confidently assumed that this early monogamy was due almost wholly to practical reasons. In rude communities, where life is maintained chiefly by hunting, men have few inducements to take to themselves many wives, especially as the labor of women has little value under such conditions. In a higher state of civilization, where people live in comparatively fixed communities and till the soil, polygamy becomes more attractive to the males. This is because it offers them the services of many persons as laborers, the opportunity of raising large families (thus increasing the influence of the head of the family in his tribe), and varied sexual gratifica-

tion. At last polygamy yielded to a great extent to monogamy in a higher state of civilization. Here, again, the reasons for monogamy are at least in part of a practical nature rather than a sentimental nature. With higher civilization comes a decrease in wars. This lowers the death rate of men to a point where it is more nearly like that of women, thus removing that disproportion of the sexes which, amongst warlike peoples, makes polygamy a biological necessity. The desire for offspring also grows less pressing, for a large family tends to become a burden rather than a help in the struggle for existence. Again, domesticated animals and machinery take the place of a plurality of wives. A most serious practical drawback to polygamy is the difficulty in giving individual paternal attention to the education of numerous children of varied heredity. In Egypt the superior position of the Copts, as compared with the Arabs, is due mainly to the better education that is possible within the monogamous Christian sect. Finally, a less practical consideration is the fact that the conditions of modern civilized life give women a better chance to maintain their health and beauty — a powerful influence in holding the husband in a state of contentment with one wife. Indeed, it is the strength of this personal attraction that determines the permanence of monogamy as an institution. As men have grown more intelligent and refined, they have grown more sensitive to all kinds of feminine charm, and hence more anxious to respect the

wishes and feelings of their life companions. The finer sympathy and understanding and the deep devotion which are often the spiritual fruition of the monogamous relation are impossible where a man has several wives. Where men and women experience this beautiful outcome of monogamy, they learn to prize it, and this is the surest guarantee of the higher races against a return to polygamy. The firm establishment of monogamy in reality expresses the slow and difficult triumph of women over the brutality and selfishness of men. This triumph is yet far from complete, and its extension to larger and larger groups of people is one of the chief means and ends of human progress. Only the atrophy of altruistic feeling can lead to the abandonment of the institution of marriage between one man and one woman.

What is the bearing of these facts on the liberty of action of individual married persons with respect to friendships and attachments to persons of opposite sex? The growth of trust and love between married persons is no real hindrance to the establishment of such friendships and attachments, but, on the contrary, serves to promote them. Where love and trust are lacking, it must often happen that unreasonable restrictions are placed on the freedom of association, and this jealousy can only do harm because it limits the best and fullest development of the partners in marriage. But whatever freedom of action is permitted, it is the verdict of society that

this should not extend to sexual relations, and this conclusion is a sound one in theory and practice. But the reasons for the validity of this conventional verdict should not be misunderstood. Freedom of sexual relations is interdicted simply because it has been shown by experience to lead in practice to bad results. Such sexual indulgence is not in itself necessarily harmful, but the risk of harm of one sort or another is very great where practiced extra-maritally. For this reason it is practically always wrong to run a risk to happiness, however strongly reason and inclination may conspire to persuade the intending persons that in their special case there can be no danger. It sometimes happens that the understanding between married persons is so generous that an almost unlimited freedom is granted by one of them to the other, without being due to any decline in personal affection. But such conditions seldom arise and should not be utilized when they do arise — and again solely because of the risk to happiness. There is the less excuse for the acceptance of such proffered liberty because all the finer possibilities of permanent friendship between man and woman may be had without resort to the relatively grosser indulgences of the sex passion. All that is best of the undeniably great charm of sex may be retained in the sentiment of such friendships and without the danger of the loss of self-respect that attends the physical gratification of sexual impulse. As the human race gains in self-control it will learn more

and more to enjoy the legitimate friendships that are possible between men and women, without the constant intrusion of the sex idea and without the risk of arousing jealousy, where one, or both, of the parties to such friendship happen to be married. But that enlightened self-control which alone can make possible the higher friendships between man and woman, and that generosity of feeling between married people which leads each to extend to the other every reasonable liberty, will continue to be rare qualities of the race so long as parents and teachers ignore the simplest biological truths relating to sex, and without a knowledge of which boys and girls are too often the easy victims of curiosity and of passion.

I

It has just been contended that the desire for freedom in the marriage relation is natural and beneficial. In actual life there is often between the partners so wide a difference of opinion as to the proper bounds of this liberty that the matrimonial ties are broken. There are few human problems more difficult to solve wisely than legitimate conditions for separation of dissatisfied couples. There is, I venture to think, one controlling biological factor which should be recognized in all questions of divorce. This is, of course, no other than the interests of the next generation. If there is a child, or the immediate promise of a child, the conditions

legitimizing separation are essentially different from those that must count in the absence of family responsibilities. Where there is no child, and no immediate promise of one, there should be considerable latitude as to separation. To limit the grounds of divorce to the usual statutory ones implies much too narrow a view of the right to individual freedom. Harshness of temper, uncongeniality, or well-grounded dislike should be sufficient ground for legal separation, for there is a considerable loss in efficiency as well as happiness from being forced to live with a person for whom one has no affection or respect. The necessity for separation involves the admission of a sad failure in the most important personal relation of life.

This failure implies unfortunate impulsiveness, or bad judgment, or low motives in entering on so vital a step. But disastrous marriages are seldom of criminal origin, and there is no valid reason why they should be punished by their obligatory maintenance. A sufficient punishment for the divorced and childless individual lies in the consciousness of failure in a relation so important, in a certain loss of prestige with decent people, and in the prolonged financial responsibility which, in some cases at least, should attend legal separation. In order to guard against a precipitate repetition of the same kind of mistake with a new partner, a new marriage should not be permitted until after the lapse of a reasonable period, to be determined by the judges granting the degree of divorce.

Where the mismatched partners have a child, or the promise of one, the problem is far more grave, and the grounds for separation should be of a compelling character based on the interests of the offspring. If it is clear that the interests of the child will suffer more through a continuance of the distasteful marriage tie than through its dissolution, the bond should be severed. If, on the contrary, there is even a fair prospect that the education, health, or general welfare of the child will be lowered by the altered conditions of life following the separation, every means should be used to prevent it. In other words, the biological criterion should here be paramount. In voluntarily bringing a new being into the world a biological responsibility is incurred which is not easily satisfied. A decree of divorce is impotent to alter this responsibility by one jot; the obligations to the child remain exactly what they were before the separation. The duty which springs from the biological relation between parent and child is simple but widely and deeply comprehensive. It is to provide the best conditions within the power of the parents for the most complete development of the inherent capacities of the child. The reader will recall that, in speaking of the conditions which prolong life and render it physically efficient, it was pointed out that there is commonly a great and measurably preventable waste of physical potentiality. Thus on the physical side of development alone the watchful and intelligent

parent has an extremely taxing duty before him. But if this be true of physical development, how much more strongly does it apply to the intellectual, æsthetic, and emotional side of the child's development! Here is an unending series of problems calling for knowledge, devotion, tact, adaptability, sympathy. With all these aids parents are sure to fall far short of the highest reasonable ideal for the psychical unfolding of their child; and the very knowledge that this is so leads the best parents to struggle unceasingly, and with the utmost earnestness, toward the attainment of their ideal. Now it requires little reflection to see that in an undertaking so complex and subtle as the serious education of a child, there is required the coöperation of both parents. If each parent separately is capable of doing real service to the child, it follows that their united efforts must be far more effective than either singly. The child should have the benefit of the different point of view of father and of mother, based on differences in temperament, experience, and sex. The removal of the parent from the sphere of influence upon the child, be it by illness, death, or divorce, subjects it to an incalculable loss, opens a chasm which can never be spanned by any substitute. For every intelligent parent should have in himself or in herself a wholly individual and penetrating action on the mind of the child, which no other person, however well trained, can exert. This power inheres in the biological relation between

parent and child, which expresses itself in certain definite resemblances of the child to the parent — resemblances in physique and in intellectual and emotional reactions. This similarity in reaction is normally the basis of a psychical penetration into the child life which is not given, in anything like the same degree, to any other person. This assertion does not hold good, perhaps, for all phases of the child's psychical life, but surely it is valid for some of them. These phases resemble an elaborate lock to which there exist only two keys — the maternal mind and the paternal mind. The fact that many parents do not use these keys, and are, indeed, unaware of their possession, does not vitiate the truth of this view.

Thus divorce deprives the offspring of a large part of that which is its most precious birthright — the possibility of sympathetic parental help. This may prove as definite a handicap in the struggle for existence as the loss of an arm or a leg. Now this parental secession from a clearly implied biological obligation, being not accidental but wholly deliberate, must be regarded as the most serious breach of trust by which one human being can damage another. The human mind is, for the most part, so preoccupied with things and with static rather than dynamic points of view, that this statement of the case will appeal to many as extreme. The more closely the position is scrutinized, the most strongly will it appeal to the sense of justice.

If the soundness of this view be admitted, it follows that the grounds for divorce should be of the most weighty nature. It should not suffice that they are the conventional grounds of sexual infidelity of one or other parent. Such infidelity is, of course, objectionable, but is, in some instances, pardonable, in the sense that it has had its origin in exceptional provocation, or under the influence of a temporary misunderstanding between man and wife, or under the influence of alcoholic intoxication or disease. It is possible for either parent to be guilty of such an infidelity and still be a helpful parent and partner. On the other hand, there are offences other than adultery which may fairly be regarded as grounds for divorce. Among them are habitual alcoholism, vagabondage, repeated and vindictive maltreatment, and an entire indifference (whether on the part of the father or the mother) to the welfare of child or children. The situations which arise in consequence of these forms of bad behavior are apt to be complex. Yet in some cases they can be cleared up by impartial and intelligent outside interference. I am inclined to think that a board of judges especially trained for the investigation and adjudication of cases in which divorce is sought would be a distinct help. The men serving in such a court should be trained in the law and, to some degree, in science, but, also, they should be experienced in human affairs, should have large insight into elementary human psychology, and, above all, should bring sympathy and interest

to bear on their work. Such a court, to serve its object best, should investigate as well as judge. It would, perhaps, be possible to stave off divorce in many instances where it is now granted. The cardinal principle in the management of such cases should be the grave emphasis of the claims of the child to the utmost patience and self-sacrifice on the part of the unfortunate parents. It seems not an impracticable idea that a highly intelligent appeal, animated by the spirit of biological truth, could be made effective in the prevention of divorce in cases where misunderstanding has been clouded by ignorance, prejudice, egotism, or false pride. Where the intelligence and temperament of the parents is of such an order that malice or deep-rooted dislike enter prominently into the emotional reactions of one or both of them, the case is hopeless and the child probably better for escaping witnessing the dissensions. But of the disagreements which now end in divorce, it is likely that a fair proportion have a less serious basis. That there are numerous instances where the extreme step of divorce is not essential to relieve the situation is shown by the good effect of the English law by which a legal separation without divorce is brought about. This plan has the advantage of preventing a new marriage, while providing for alimony and leaving open a chance for ultimate reconciliation.

The same biological considerations which, in general, make divorce a misfortune for the children,

would operate with still greater force under the socialistic measures which propose to leave their case to the state. It is difficult to picture a less intelligent and more grossly antibiological idea than that which would separate parents and children. An equally antisocial measure can hardly be conceived, for to separate a family from the people naturally best endowed to rear them would be to rob the community of the human qualities that make most strongly for the civilization based on individual development, since there can be no doubt that most of the best social traits are those developed through family relations. But it is only fair to say that this insane idea is far from being a representative tenet of socialism.

II

Is it possible to regulate human reproduction in such ways as will inure to the advantage of a community or nation or race? To what extent and under what conditions can human reproduction be controlled? These questions are so involved as to invite evasion. Yet it is certain that no discussion of the sex instinct can afford to ignore a matter of such fundamental importance. If we are unable to reach final conclusions on the main issues which the questions suggest, we may at least examine some of their biological aspects.

The physiology of reproduction is so well under-

stood that the regulation of the size of human families does not present great difficulties where the parents are fruitful. Over the sex of children there is, at present, no control, despite the many claims to the contrary. All attempts to influence sex after conception has occurred are, of course, quite futile in view of the fact, already stated with sufficient clearness, that sex is determined at the instant of fertilization. The control over the numbers of a family is, on the contrary, considerable. It is naturally much easier to make certain of having a small family than of having a large one. Although it is, in general, true that during the intermenstrual period there are a few days during which conception seldom occurs, it is also true that there is no time between puberty and the menopause at which impregnation may not occur in a normal woman. So it is evident that while there is usually little risk of conception during some intermenstrual days, this does not suffice to make conjugation without an element of risk of impregnation. So, in order to be quite certain that there will be no additions to a family, there must either be a total abstinence from sexual relations or a resort to artificial means of preventing conception. The former course is one that is not likely ever to be looked on with favor, and is, in fact, unreasonable. On the other hand, it is possible to prevent conception by artificial methods which are not open to objection on the ground of endangering physical health. Even the thought of resort to

such methods offends the sensitive mind, particularly if unused to questions of this sort, but it quickly grows obvious that, in the case of normally fruitful couples, there are only two alternatives. The first is a degree of sexual continence, which is for most persons impracticable. The other is the risk of having a larger family than reasonable prudence makes desirable — a family so large as to be an excessive physical tax to the mother, an excessive tax on the money resources of the father, and, furthermore, so large as to stand in the way of the best development of the individuality of the children. One may well ask whether, in general, it is not wiser to employ anticonceptual methods than to bring into the world more children than can be decently cared for. It is, of course, quite impossible to set any arbitrary standard for the number of children a couple may prudently attempt to rear, since individual standards must vary widely. All that can be said is that a conscientious effort should be made to steer a course between the policy of a family of only one or two (a policy commonly dictated by excessive monetary prudence or erroneous social aims) and the *laissez-faire* abandonment which takes no heed of the morrow and ends in a regrettable lowering of physical, psychical, and general cultural standards. It is noticeable among cultivated persons that they are willing to approve of large families for other people, leaving little margin beyond decent housing, clothing, and diet, and ordinary chances of

education. But if we ask these very people whether they would be willing to attempt the rearing of a family under such pinched conditions, they will generally give a negative answer. This clearly because cultivation brings æsthetic and educational needs which require larger financial resources for their satisfaction.

But the question of the size of the family cannot be settled from the standpoint of the individual family alone. There is a far broader point of view which must be kept in mind — the effect of the size of the family on the general welfare of the state. And it is just at this point that the question becomes extremely complicated. It is relatively simple for a given couple to decide that they cannot wisely undertake to rear more than three or four or five children. To be sure, it is true that in so limiting the family there is a somewhat arbitrary exclusion of other possible children who might have exceptional talents. Yet this is a vague possibility in which the world will probably never greatly interest itself; and we may conclude that the arbitrary limitation just suggested is, from the standpoint of the parents and family, both legitimate and prudent in a praiseworthy sense. But what shall we say of this policy in its relation to the state?

The first consideration that strikes us is that the people most likely to limit their families in a legitimate and intelligent way — from the standpoint of the family itself — are just those who are the most

enlightened and most desirable members of the community; and, furthermore, that the exact converse of this is also true, that the most reckless reproduction is to be looked for among the least educated and poorest classes. The effect of this tendency is, of course, just the opposite of what is most needed, and is restrictive of the best elements of the population while placing no restraint whatever on the multiplication of the least intelligent and poorest people. There is evidence that this tendency is actually operative to-day in the United States. Here the conditions are now distinctly antagonistic to any restrictions among the lowest classes, and are likely to remain so while so much territory remains underpopulated, in the sense that it holds natural resources able to give profitable occupation to large numbers of unskilled laborers. Probably the only way to induce the lower classes to limit their families is to educate them to higher standards of living by arousing better ideals of attainment and of comfort for their children. But how is this to be done when there is such a demand for cheap labor as exists to-day in the United States?

For my own part, I own to a leaning in the direction of considering the quality as well as the numbers of our community. One cannot help suspecting that the interests of the country and of the race would be better served by striving to elevate the ideals and attainments of the laboring classes than by encouraging the mere increase of their numbers as is so largely

now the case. The desire to gain wealth is so great that we see about us a feverish eagerness to develop the resources of the country, and far too little regard for the state of culture of the human organisms operating as the agents in this extension. This is doubtless the natural policy for a relatively new country, but it is a thoughtless one, and one fraught with danger to the state if allowed to dominate unrestrainedly. The danger is that which threatens every community that allows a large untutored and undisciplined element to arise in its midst. In times of prosperity and extension this element may be relatively governable, but in times of stagnation it will easily be led by the appeals of demagogues toward acts of violence and disorganization, which block real progress by provoking reactionary sentiments in a large part of the community.

In the case of a country like the United States which has a large and wealthy population as compared with other world powers, and which, owing to its geographical position, is largely protected from the attacks of militant states, the problem of population seems relatively simple, at least in so far as ideals are concerned. For such a country it is a mistake to encourage an increasing population of unskilled labor, however great its resources may be in mineral and agricultural wealth. Far preferable would be a policy which should have for its object the restriction of the lowest class of labor to the needs of a moderate material development. Such

a course would tend to secure an increased proportion of skilled labor; that is, of labor capable of creating a larger per capita yield of wealth. But this is only another way of saying that a share of leisure time would be placed at the disposal of people who now have none. Such a change marks the most significant of all steps toward social betterment. It does not follow that the newly acquired leisure would be at first well used. Doubtless much of it would, in the beginning, be wasted and abused. But here at least would be that opportunity for improvement without which no nation can advance in general culture and ideals. Time and experimentation would afford the chance to use this leisure for better and better purposes, for thought, for the enjoyment of society, and for legitimate amusement. It is exactly at this stage, at the period of awakening interest and desire for self-betterment and family betterment, that the ability to control the size of the family becomes an asset of incalculable value. Where the margin of income above actual needs is small, it makes an enormous difference for the outlook of a family — educationally and socially — whether there are two or three children to rear, or six. The smaller number is compatible with reasonable educational opportunities and a degree of comfort which wards off discouragements of the struggle with outspoken poverty. The larger number almost surely means neglect of some of the children, and the depression of the prospects of all.

These considerations show clearly, I think, that those who are most influential in the control of the destinies of our people should, on the one hand, encourage and stimulate them to leave the ranks of unskilled labor, and to enter those of skilled production, while, on the other, they teach them the immense importance of being able to regulate the size of their families. These two aims, when once their combined influence is understood, must prove potent measures of elevation for the lowest classes. It may be objected that it is impracticable materially to facilitate the entry of the unskilled laborer into the class of the skilled workman. The more careful examination of this question is one which must be postponed to a later chapter, and the subject may be dismissed for the present with the remark that the contention just now — that the unskilled can be developed in order to swell the ranks of the skilled — is based on the proposition that increased production of wealth per capita is certain to follow the wider extension of those scientific methods of production which modern inventiveness has placed in our hands. The only real obstacle to the realization of a greater per capita income, following an advance in skill, is the extensive exploitation of labor by capital, which, in the absence of intelligent legislation, might result in the diversion from the skilled workman of a larger portion of the increment dependent on his skill than could be considered fair.

The regulation of population is a still more compli-

cated question in a country threatened by a militant enemy of approximately equal efficiency in war. In such a case, the control of reproduction has to be considered not merely from the standpoint of the family, and of the nation, but in its international bearings. It is well known that the population of France has remained nearly stationary during a number of years, while that of Germany, her most dangerous neighbor, has considerably increased. The small families of the French appear to be due to artificial regulation of the reproduction practiced from a desire for the maintenance of a fairly high standard of personal comfort. It seems as if this policy had been carried too far for the good of the country as a whole. For, in this case, the danger of military aggression from adjacent countries is doubtless somewhat increased by a policy that is relatively weakening. But this is not the sole objection to the French policy with regard to reproduction. It seems as if the limitation of the size of families is influenced much more by the mere desire for comfort — largely by selfish motives — than by the wish to give better opportunities for the culture and efficiency of the children. If this be true, is it not likely that in time France must lose prestige in many directions by a continuation of a restrictive policy founded too largely on selfish motives? This example of restriction of family thus appears to show that here limitation is not necessarily wholly beneficial. It is the combination with the desire for improvement, and

this alone, which gives a biological sanction to the interference with natural tendencies in population.

The case of large countries with a swarming population and low standards of living must also be considered in estimating the effects of small families in more highly civilized neighboring countries. The "yellow peril" which threatens Europe has loomed large for many a generation. Will the Chinese try to invade the western strongholds of civilization? And if so, can their numberless hordes be successfully checked by the inferior numbers of the more cultured nations? Every one is entitled to a prediction on these momentous possibilities, but it is doubtful if the greatest living statesmen have at command the data to enable them to make predictions worthy of credence. It is likely that the risks of Mongolian invasion have been considerably exaggerated. The nations of the West, though inferior in numbers, have a relatively high level of intelligence, far more imagination, and an incomparably greater capacity for rapid adaptation to new conditions. These are qualities which must powerfully influence the outcome in any conflict between the highly organized and disciplined forces of the West and the heterogenous hordes of Cathay.

But it is quite aside from the purpose of this chapter to speculate on the international aspects of the question of human population. I wish merely to indicate that there are important international phases of the question which may perhaps modify

conclusions drawn from its national and family side. The fact which emerges clearly in the midst of conflicting considerations is that, so far as individual families are concerned, an intelligent restriction of family looking to the improved education of its members is strongly to be desired as a step — and probably an essential step — toward the legitimate individualistic development which must precede or accompany improved social ideals and practices. The control of the size of the family, in the sense already discussed, is largely practicable. It is one thing, however, to know that this regulation is possible and desirable; quite another to introduce it into intelligent practice. Nevertheless, if the biological and sociological aspects of the problem of regulation should once become generally understood, it is reasonable to think that intelligent regulation would slowly — very slowly — come into operation among many more persons than is at present the case. The aim of restricting the families of the poorest workers should, of course, be bound with the aim of encouraging a generous fruitfulness among the middle and upper classes of society. It is especially among the very rich that serious difficulties would be encountered, for here we meet frequently with aims which seldom take root among persons of moderate means — aristocratic views of life which demand large estates, great houses and equipages, private galleries, yachts, etc., for their satisfaction. But even in these not very promising cases education must ulti-

mately do something to make the love of accomplishment supersede in a measure the love of mere lifeless things, to make dynamic ideals displace static ones. The desire for large and capable families, able to make a mark on the events of the day, — able to promote the welfare of society, — must inevitably form a part of this better appreciation of the dynamic ideals of civilization.

The sexual instinct is a topic of almost inexhaustible variety and interest, and its discussion might be almost indefinitely extended. But for the purpose of this essay enough has been said to show how this instinct, protean in its manifestations and frequently veiled by other feelings and emotions, must enter, prominently at times, into the life of nearly every natural and normal human being. While it is clearly in the interest of culture that this instinct should disport itself healthfully within limits not quite clearly definable and varying with temperament and many a circumstance, it is incontrovertible that trifling with the impulses of sex is perilous beyond the understanding of the vulgar imagination. Interwoven as are these impulses with all the vital tissues of thought, feeling, and motive, their thoughtless exploitation is capable of bringing disorder and degeneration in a hundred ways. That such mistakes are often pardoned by nature is certain; but it is equally sure that she exacts large and even fatal penalties from many an imprudent devotee at Venus's shrine. Here, indeed, is one of the important ways

of eliminating from the world, through the operation of natural selection, innumerable individuals whose faults are those which are so readily grafted on unstable nervous systems which have never learned the art of inhibition. So quietly does the process of exclusion go on, so little obvious may be the sexual basis of this exclusion, that the selective process proceeds for the most part without the definite consciousness of its victims — who often derive a pitiful satisfaction from imputing to accident or ill luck, or the malice of providence, those misfortunes which they have brought upon themselves. Who can doubt that, in time, when the perils as well as the benefits of the great gift of racial instinct are seen in the white light of biological truth, there will be a large gain in self-control and consequently an incalculable saving of human misery?

CHAPTER X

THE MALE AND THE FEMALE MIND

Of the human questions that are always before us, few are more elusive than the precise nature of the differences between the male and the female mind. That psychical differences do exist between the sexes of the same race has long been apparent, and the widespread interest in them is reflected in the literature of fiction and the conversations alike of everyday life and of polite society. The subject is one about which nearly every mature or half-grown person has views. These views are based on a limited and casual observation of people with whom there are family associations, of the contacts of friendship or business. Usually it is the intimate ties of family life that determine individual opinion as to differences between masculine and feminine qualities. The father of the family forms his judgment largely of feminine nature from observation of wife, mother, sisters, daughters, perhaps also of a few women friends. I believe the philosopher and the psychologist does exactly the same thing — forms his judgments on an extremely limited number of individuals. The experimental psychologist may measure the reaction time of a larger group of women and a larger group of

men, but these studies do not take him far below the surface of the problem, and his published opinions of women will be almost surely based on the general view of them which he has formed from an intimate acquaintance with his wife. If he is an unmarried man and has never had a mistress, his views on the comparative psychology of man and woman will necessarily be of an unreliable nature and liable to smack of the pedantries of science.

There is, in reality, nothing surprising about our ignorance of the actual psychology of man and woman. The bare fact is that the attempt to point out the differences between the masculine and the feminine mind is a resort to that comparative method in science which always serves so well to expose the limits of our knowledge. In this case, it convincingly shows us how scant is our real acquaintance with the psychology of the most fundamental instincts. Why should we deceive ourselves into the belief that it is otherwise? When we consider the unparalleled complexity of cerebral structure and the short time that we have known even the most elementary forces in chemical and physical science, what reason have we to think that even the most accessible functions of the brain should have been solved?

The appeals which have been made to anatomy and to physiology for the solution of this question have been, in my judgment, about equally fatuous. From anatomy we learn that the female cerebrum appears to be a little smaller, on the average, than in

man, even making allowance for the difference in the weights of the entire body. We learn also that the frontal lobes (admittedly the main seat of mental activity) bear about the same relative proportion to the rest of the cerebral hemispheres in women as in men. Meinert, Mercier, and others hold that the frontal region in women is relatively a little less developed than in men, but Professor Mall tells me that he has found the area of the frontal region in women to bear just the same relation to the remaining areas of the hemispheres as in men. I am unable to see that the data available from anatomical studies of this kind throw any real light on the psychology of men and women. The difference of organization between the male and the female brain must lie mainly in variations in the representation of different functional regions and in consequent variations in the arrangements and connections of the numerous types of nerve cells that are concerned with consciousness. To expect to gain any insight into these intricate structural arrangements by gross observations on brain weights is mere folly. On the other hand, the best methods of investigation now open to us are so difficult and laborious, so inadequate in comparison with the problem to be solved, that it is no reflection on anatomical science that it has not essayed really fundamental researches into the fine structural differences that probably determine the divergences in the psychical characters of men and women. Indeed, the failure to make serious trials in this field

is at once a tribute to the intelligence of anatomical investigators, and a recognition of the transcendent intricacies that inhere in profound studies directed toward the most elaborately organized of all structures. The methods of physiology appear to me almost equally ineffective for dealing with the highest cerebral functions. They have failed to give us any satisfactory conception of the differences between the sleeping and the waking brain, or of the nature of the nervous energies which are concerned with sensory and motor functions. How, then, can we expect from physiology a solution of the question of sex differences as manifested in psychic activity? Psychological measurements reveal some facts of interest, yet impinge but lightly on the essential problem.

So we find ourselves in a position where we have to rely mainly on empirical observations, making the frank admission that the differences which we discern, or fancy we discern, cannot at present be subjected to satisfying biological analysis, and feeling that great advances in method will be necessary before we can hope for true progress.

The essential differences between the mental life of woman and that of man apparently depends upon the fact that the cerebral organization represents and reflects the various aspects of the sexual functions, which irradiate, as it were, into the brain. The circumstance that the body of the mother nourishes both the embryo and the infant brings her into an organic relationship to family different

to the casual relationship of the male. It anchors her, figuratively speaking, by a short cable to the central interest of family, forcing on her a relatively sessile life. The protection to the child given by nature leads the mother to continue this shielding action in many ways during the life of her offspring. Through such association the mother gains an acquaintance with the multiple physical and mental needs of her children, unattainable in any other way. Maternity is, indeed, the natural school for the cultivation of affection, sympathy, tact, self-sacrifice, patience, and the quiet endurance of physical discomfort. The pressing nature of so many childish needs gives an intense practical tendency to the interests of the mother. She thus comes to have regard for immediate results rather than remote ones, for details rather than for principles. The close contact with her children also sensitizes the mother to the most elementary human appeals. It seems as if such reactivity and understanding must render sentiment more delicate and discriminating than in man, and impart to it a greater variety of shading. This experienced sensitiveness to the stimulus of human appeal is, I think, the basis of the element of charm in women. The same labile quality exists in some men and is an element of charm in them also, especially when associated with intelligence and forceful character. An extremely important feminine characteristic is the desire for definite expressions of affection. The need for such expres-

sions is, I believe, far greater, in general, in women than in men. Men, preoccupied with the active struggle for existence, or with the pursuit of a creative ideal, too often lose sight of the craving for affection which is inborn in their wives.

The less direct attachment of the male to his family gives him the wider swing which brings greater opportunity to explore and make varied experiences with things and forces. This wider scope, operating through an incalculably long period of evolutionary activity, may well afford an explanation of the greater originality of men in meeting new situations, whether practical or intellectual. The larger point of view, the better faculty of discovery, the superior ability to make new combinations, give to men a self-confidence and a pride in achievement which is more developed than the corresponding attributes of women. The better developed male sense of justice in respect to large questions, and the greater willingness to take risks for the sake of an ideal, are probably connected with the superior capacity for correct generalization and the greater self-confidence. The sacrifices and suffering which come from mistakes in economic policy fall with special severity on women and children. Women have thus grown conservative as to social experiments. Men, on the other hand, often overconfident in their own judgments, more readily make risky experiments, whether in good or in bad causes, and this willingness may be attributable in part to

the relative immunity from personal suffering after the disastrous outcome of such experiments. Energy of performance or will power, as it is commonly called, cannot, I think, be compared in the two sexes without the risk of reaching an erroneous conclusion. It is a faculty eminently difficult to judge. Men seem to me more apt to parade their energy of performance, and this ordinarily creates the impression of stronger will; but it is easy to underestimate the quiet determination of women. Men exert themselves especially to gain money or to secure some advantage or indulgence for themselves, or to create a product. Women have much less insistence and energy of performance in respect to creative work, and are more readily diverted. Forel says that women have somewhat stronger wills, on the whole, than men. But, of course, this opinion is only of value as the impression of a highly intelligent and experienced scientific observer of humanity on its psychological side.

The greater masculine power of creative imagination finds one of its most striking expressions in the immensely superior achievements of man in poetry, music, and art, for in these fields the refined sensibilities of women should give them a foothold, and even an advantage over men. Indeed, if we compare the average man and woman, or even highly cultivated men and women, I think that we shall find no feminine inferiority in respect to the understanding or rendering of music and poetry. But it is plain

that the most highly creative men (an extremely small group) have remarkably excelled the most highly creative women in poetry, music, and art. When we seek the explanation for this inequality, we come face to face with one of the most difficult of human problems. Does the superiority of the greatest artists arise from the exceptional opportunities which they have had to educate themselves, or does it arise from a superiority of organization in the male, consisting in a more richly developed specific mnemitic heredity? It is self-evident that qualities which do not inhere in the mneme, owing to hundreds of thousands of years of heredity, cannot be formed in a few generations, no matter how much education is available. Even if we tentatively make the large admission that acquired mental characters are, to some extent, though very slowly, inherited, education cannot equalize the sexes in respect to the qualities which are characteristically male or female. But it is extremely difficult to say with confidence what traits are characteristically male or female by inheritance, since there are no male qualities which the female may not exhibit and no female qualities which the male may not exhibit. The peculiarly strong and tender devotion of a mother for very young children is, perhaps, the most distinct of psychical sexual traits, being rarely seen in the male parent. This may reasonably be interpreted as a quality based on mnemic heredity. When we come to deal with the intellectual and emotional qualities

which enable a man to write poetry or compose music of the very highest grade, it is extremely risky to form a definitive judgment. It is possible, though by no means certain, that this superiority has a mnemic origin, or depends on some other form of superiority in respect to cerebral organization. But there are some things about our methods of education which we must not lose sight of in this connection. Assuming that, in a given community, there is an equal number of boys and girls of approximately equal gifts, it is certain that a far larger proportion of the boys would be permitted or encouraged to develop their powers than would be the case with the girls. The boys would be encouraged by conventional parents to make a fairly free use of their gifts, and their irregularities of conduct in their efforts to choose their own paths would be pardoned them on the ground that they have careers before them. But the girls would be suppressed at every step, and the ideal of gentleness and personal attractiveness would be continually impressed on their minds, thus effectually checking or diverting their talents. Under such conditions it would not be surprising if the most gifted boys made a better showing in creative work than the girls. I do not say that this is the explanation of the disparity between the most gifted men and the most gifted women in poetry, music, and art. Indeed, I believe that it cannot be the full explanation of the difference. But until girls and women generally have opportunities

more on a parity with those of boys and men in respect to education, it will be impossible to estimate justly the degree of the assumed inherited disparity between men and women in the highest types of creative endeavor involving an æsthetic factor.

That there is a profound difference between the attitude of men and women toward some of the most important questions must be apparent to all who have taken the trouble to observe and think on the subject. Men are, it would seem, much more determined to carry on creative intellectual pursuits for the sake of the satisfaction that is derivable from such activity. When women are engaged in occupations of this kind, they are more readily turned aside by claims of family or friendship, and even by less excusable distractions. Whether this difference is an inherent one, or one due mainly to educative and conventional habits it is not possible to say with certainty, but we may suspect that there is an inherent divergence which no amount of education can wipe out. We have to remember, in comparing the minds of man and woman, that the intellectual superiority of man is only apparent among the highest types of the race, and that if there are many ineffectuals among women, there are probably quite as many among men. Among educated people, in general, it is difficult to discern any real superiority, even of an intellectual kind, on the part of men. There is, I believe, a strong tendency to lay too much

stress on the intellectual and productive superiority of men of the highest capacity. These qualities undoubtedly count for very much in the world's progress and are given a wide celebrity. But it is by no means clear that the fine critical and human qualities of the greatest women do not contribute quite as much to progress, if in more indirect ways, and with less public acclaim.

Any comparison of men and women, from the standpoint of their importance to the race, must be futile if it aims to establish a general superiority on the part of the male. And it seems to me that nature relieves us from the necessity for making painful academic efforts in this direction. For her indications, as we read them to-day with the help of scientific methods, all point to the fact that in the production of a new individual, the mother and the father contribute in equal degree that material which is the bearer of hereditary qualities. In the equality of this fusion it makes no difference whether the new being is a male or a female. In either case each parent gives approximately the same quantity of nuclear material. The mother, indeed, contributes the larger share of the total material of the impregnated egg, but this is due to the circumstance that the egg has material surrounding the essential nuclear substance. This enveloping material is to be regarded as nutrient pabulum, and not as the carrier of hereditary potentialities. Nor is there any reason to think that the materials furnished by the female

are less significant in function than those coming from the male.

It is not merely at the outset of life that this equality of contribution to the new campaign is recognizable. In every division of the cell the new nuclei continue to hold equal quantities of male and female substance. So that finally, in the adult being, there is the same strict equality of representation as at the beginning. If we believe in the mechanistic theory of the nature of living organisms, are we not compelled to admit this hint of essential equality in male and female? How is it possible that one sex should be superior to the other in any natural sense, when both male and female are in equal degree, and with the utmost mechanical precision, the bearers of the heritage-laden substance from each parent? When we add these quite definite biological indications of equality — not sameness — to the somewhat less definite indications derived from the consideration of the developed human male and female, we are at a loss to find any valid reason for giving to the male sex a position of superiority in political, legal, and financial privileges. The disadvantages under which women still labor are largely those which have been forced on them by inconsiderate men as the result of the superior brute force which they possess. As ideas of justice and decency grow, mere force must gradually count for less. It seems entirely clear that in Anglo-Saxon countries women will not be satisfied until they have reached a status of equality with

men in respect to political, legal, financial, and educational privileges and opportunities. Such equality does not imply that identity of aim will follow. It does not mean that women will try to equal men as surgeons, as practical politicians, or as stockbrokers. But it does mean that the removal of artificial disabilities, mainly born of masculine selfishness and feminine helplessness, will give to one half the population a better chance for the development of personality. A gradual change in this direction would accord well with sound ideals of human progress on biological lines.

The sexes differ rather widely in the expression of interest and affection for each other, and conjugation is preceded almost universally by some play or sport or negotiation. Indications of this are seen even among relatively low animals in which gallantry comes as a surprise. The dance of the male and female scorpions, claw in claw, is a case in point. Among birds the males practice coquetry and are endowed with superior attractions of voice and plumage. In mammals, generally, the rôle is reversed, and the female possesses the qualities and means of attracting the male. In the human species it is with few exceptions the male that assumes the more active rôle of seeking his mate, but modern society has developed the art of feminine attraction to a remarkable level of efficiency, and it may even be said, in some instances, that the female is covertly, or even openly, the seeker. In general, however, the

male takes the initiative, while the female consciously or unconsciously practices the art of coquetry which presently makes so strong an appeal to the masculine personality.

Perhaps there is no human relationship in which both innate qualities and breeding are more clearly exposed than during courtship and its attendant flirtatious expressions. The element of sexual attraction normally enters into this relationship, but its prominence varies between the widest limits, and is determined much more by temperamental reactions than by the grade of cultivation or social position. If a disgustingly active animal side of human nature is revealed in some of the methods and processes of flirtation among certain types of people, it is equally certain that there is a highly refined play of sex and intellect which distinguishes the amorous advances of other sorts of men and women. Instinctive feelings and reactions play a very large part in the orientation of both male and female nervous systems with respect to the meaning of the advances which are made and the extent of the grossly sexual factor. Thus women with discriminating nervous systems often show great acumen in detecting the element of coarseness in men, or the existence of a sexual attraction dissociated from affection and respect; and this largely intuitive cognizance may become the basis of strong antipathies. Some men also have a partly or wholly intuitive appreciation of the dangers that lurk in the artful ways of some kinds of women, and

though perhaps attracted by them, are able to make an escape before committing themselves. Others are less fortunate or, perhaps we should say, less gifted in their amorous or sexual perceptions, and find themselves linked by matrimonial ties to women whose main attraction has been their coquetry. These are, of course, the marriages that yield the highest percentages of divorces. Men are perhaps, in general, not so well fitted as women to steer their way safely among the shoals and rocks of flirtation. The advantage of women in this direction lies, I think, in their better intuitive responses (or to express it in physiological terms, in their more correct nervous reactions) to elementary human qualities — an advantage which may have its basis in mnemic heredity. The egotism and self-confidence of men carry with them many little vanities which are easily played upon by clever women, determined to please, and willing to stoop to conquer. Men of affairs, who have learned to triumph over other men, are especially prone to mistakes in dealing with the fair sex. Those who are shy by nature and modest, and have had little chance to observe women, are apt to get into unfortunate matrimonial situations, especially if they readily react in emotional ways. Great intelligence does not protect them, as the somewhat pathetic but amusing case of Abraham Lincoln clearly shows. One of the most eminent German scientists, to whom mankind owes a large debt, is quite under the domination of a wife far inferior in capacity, who

manages him by the most clever appeals to his sense of importance and by a thorough understanding of his sensual nature. The methods by which women sometimes play on the weakness of strong men are truthfully and vividly described by Thymian in her pathetic "Diary of a Lost Soul." Men and women who are bent on illicit sexual gratification are often wonderfully acute and quick in singling out likely and congenial partners. There seems to be, indeed, a veritable art of seduction, and a cynical writer has said that the successful seducer, like the poet, must be born. While the knowledge that such traits exist, not very rarely, is unpleasant, the fact must be regarded simply as a natural phenomenon representing an extreme phase of a natural and legitimate instinct. The absence of sexual feeling, and the complete lack of any instinct to flirt in legitimate and decent ways, is certainly not to be counted a virtue. The play and sparkle of wit and merriment which is provoked by the admiration or liking of one person for another of opposite sex are among the most charming and delightful of human experiences; and among intellectual and cultivated people of artistic temperament a moderate indulgence in this kind of play may develop into an art which is not to be scorned. Based as it is on the employment of reciprocal male and female psychical qualities, — and in this sense sexual in origin — it is absolutely devoid of grossness. I think it true that this kind of attraction is of great importance and benefit in its

effects. When it is founded on the reciprocal recognition of congenial traits, it may lead to marriages based on an element which has much to do with securing the permanence and agreeableness of human ties. The happiest marriages are undoubtedly those in which an element of romance is a permanent feature. The full force of sexual charm and love, devoid of sensuality, is one of the most powerful influences in life. It is a power which makes for gentleness, consideration, and self-sacrifice and, indeed, for better ideals generally. It is strengthened by the possession of children, but may exist without them. It may also exist for a lifetime between unmarried people, whose affection never has been based on anything approaching the sensual side of sexual instinct. It is, I believe, a power of the first importance for the elevation of the race. But in its most ideal forms it has probably hitherto come within the experience of relatively few human beings. It seems not unlikely that this higher sort of affection between the sexes is destined to become more diffused as the races meliorate, and that it will one day become a far greater force in the general uplift than it is to-day.

BOOK IV. THE FUNDAMENTAL INSTINCTS IN THEIR RELATION TO HUMAN DEVELOPMENT

CHAPTER XI

THE ARTS AND RELIGION

The following discussion is based on the view, developed in preceding chapters, that all animals, including man, are literally automata; that is, machines whose conduct exactly reflects their physical organization. This view does not overlook the difficulty of accounting for animal evolution on the ground of existing scientific knowledge; but it assumes that, given the developed machine, the hypothesis of automatism, in the most complete form, accounts for the facts of animal life better than any other. And it not only endeavors to account for the most obvious and grossly mechanical functions of the organism, such as the circulation of the blood, the mode of locomotion, or the formation of images on the retina, but also sees in organization the full cause of conduct in its most varied phases, and the basis of all kinds of mental processes and emotional and ethical reactions. Human conduct on this hypothesis is the extremely intimate and elaborate train of nervous reactions that ex-

presses the felt-like interaction of environmental forces with the forces pertaining to organized protoplasm. That such an hypothesis must at present content itself with supports mainly of a very general character is only a form of admission that we are still profoundly ignorant of the subtle processes that hold sway in the substance of the nervous mechanism. The progress of investigation can be counted on to do something toward making this extreme materialistic or mechanical hypothesis either more reasonably tenable than now or less so. It is put forward here because it appears to me more legitimate at present than any other, and better adapted to stimulate research and to promote kindly human relations.

What most deeply interests the student of human affairs is to gain some vantage ground, or point of view, from which he may venture to predict the tendencies of human development. Is the race to improve, according to our present-day best standards of what is desirable, or is it to degenerate? Or will it improve in some directions and deteriorate in others? What would we not give for a glimpse into the future which should give us substantial knowledge of the outcome? As it is, we are constrained, with limited and halting powers of imagination, to picture the future with the help of grossly imperfect knowledge of present conditions, and an even more inadequate understanding of the past.

From the standpoint of our mechanistic conception the future of any race will express the behavior or

reaction of its protoplasm — and mainly its nervous protoplasm — toward the environmental forces which serially impinge on it. If the impinging forces of environment are at present so numerous, so complexly interwoven, that we imperfectly comprehend them, what right have we to talk of their future effects, in the presence of an undeniable tendency to still further complication of forces? And correlatively, if we know so little of the basic forces of protoplasm and the memories engraven there, how shall we presume to predict the future properties and reactions of this inexplicable maze of material? Discouraging as is any truly scientific approach to the prediction of human developmental tendency, it does no harm to realize the nature of the difficulties, even though such realization serves no other purpose than that of preventing us from being too exacting in our prophetic demands.

I propose to consider here, in a brief way, the various types of human nervous reaction with which we are acquainted, in their relation to human development. Empirical experience must be our main guide in this endeavor — and, strictly speaking, most of what we know of biology may without injustice be classed as empirical knowledge. As already pointed out repeatedly, the fundamental nervous reactions in man, as in lower animals, are only two in number: the self-preservative and the sexual. While these distinct reactions subserve quite distinct though harmonious biological ends, the reactions are linked

to each other in many ways. Moreover, these reactions and the instincts which they express are bound closely to certain derived reactions. And these reactions are, in turn, so closely bound, and indeed overlap in so many ways, that the undertaking of separating them for separate discussion is an arbitrary one. Nevertheless, it is profitable to think of the derived or secondary nervous reactions in their bearing upon the acquisition of knowledge, on the growth of æsthetic experience, and on the development of ethical qualities. That the growth of these derived reactions is destined to affect profoundly the parent reactions from which they sprang — the survival and sexual instincts — seems an obvious conclusion, and there can be no reasonable doubt that this reflected influence must profoundly modify human conduct.

I

Art, the skilled expression of beauty through human agency, stands in close and relatively obvious and tangible relation to biology, because it is mediated very definitely by specific and known nervous mechanisms. The relation of the optic or second cranial nerves to painting, sculpture, and architecture is similar to the relation of the acoustic or fifth cranial nerves to music. In each case the artistic product is in part based on the function of the analytical and representative powers of special sense organs. Other sensory cranial nerves fall far below the optic and acoustic in analytical faculty. The

first or olfactory, the nerve of smell, is atrophic in man and can subserve no creative art, although in dogs it is the basis of wonderful feats of scent, and even in man may subserve purposes compounded of useful and æsthetic qualities. The fifth and ninth nerves also supplying the sensations of taste, although susceptible of a training which permits a high degree of sensory discrimination, *e. g.* it is shown in the tea-taster's art, hardly rise to the dignity of subserving a productive art.

The sensory cranial nerves and their central connections, however, are not the sole basis of the expression of the beautiful, for in the muscular sense and the joint sensations, based on nerves of general rather than special sense, we see the basis of a primitive and exquisite art, the art of dancing. This art, perhaps the simplest and most generally intelligible, owes its general character in part to the wide distribution and nonspecific nature of the nervous mechanisms on which it depends, and in part to the noteworthy fact that both time and space relations are equally prominent in its expression. But as the muscular and joint nerves have no distance receptors, *i.e.* no mechanism for establishing contacts with phenomena at a distance from the body, the dancing art is greatly limited in content and meaning, as compared with painting and music.

The nerves of smell, of taste, and of sexual sensation need here only be mentioned as the instruments of sensory experiences capable of becoming organized

into useful or pleasurable practices which are not without some pretense to recognition as arts. We are concerned here mainly with the meaning and future of those æsthetic arts which subserve the beautiful, and it will perhaps be most profitable to compare dancing, music, and painting in some of their more patent biological relations.

II

It is in dancing that the human form can be seen most effectively in its appeal to the sensual aspect of beauty. According to the intelligence and motive of the dancer, this appeal may be on a low or on a high plane, either operating as an incentive to abandonment of personal restraint, or as the awakener of noble feeling. Or the influence may be more indifferent and consist of arousing delight and a pure joy in the grace and elegance of varying motion. But even at its best, dancing cannot be counted as vying with painting or music in expressiveness or intensity of appeal. The relatively unspecialized nature of the machinery on which the sense of position depends is incapable of subserving more than this one primitive and rather generalized function, and this operates against richness of content and variety of significance in the dancing figure. The fact, too, that the entire muscular mass of the body may be implicated in the motions of dancing militates against concentration of faculty and hence against the highest expressive-

ness. Through its operations in both time and space, the dancer's art gains its peculiar charm of grace, while at the same time losing in intensity. We can best see this by contrasting the effect produced by a beautiful human figure in the motion of dancing with that produced when the figure assumes a fixed position. In the fixed position the effect is like that obtainable by sculpture, the space expression being shorn of any time and rhythmical element. The fixity so gained at once becomes the means of a gain in seriousness and intensity of expression, an increase of dignity. Fixity of position in a significant attitude imparts the suggestion of the fixity of fate, of the inexorable, and thus gives to sculpture its peculiar impressiveness in dealing with the larger human emotions. Thus it appears that there are definite biological reasons for the relatively restricted appeal of dancing as an art. It seems certain that dancing will be employed more and more in the future for expressions of the milder forms of human delight, the joy of motion in rhythm, and the healthful expenditure of stored muscular and nervous energy. On the other hand, it appears certain that no great development is to be expected in the range or intensity of its appeal to human faculty and emotion.

III

Incomparably more analytical of the phenomenal world are the eye and the ear as compared with the

muscle and joint senses. Hence we should expect that the æsthetic products based on them, as, for instance, painting and music, would transcend dancing in expressiveness. The retina, the instrument for the distinction of luminous waves of varying lengths and innumerable color tints as well as the receptor of form images (dependent on gradations of light and shade), receives those pictures of the external world on which are constructed all works of painting and sculpture. These pictures are carried to the central nervous system by direct and crossed pathways, and not merely rise into consciousness, but leave residua which may be revived under certain conditions. The visual receptive apparatus becomes so practiced through multitudinous experiences that it has the power of apprehending and reconstructing entire objects or even complexes of objects from partial views of them. There are two peculiarities of the visual apparatus and tracts which exert a fundamental determining effect on the quality of the impressions received by the eyes. One is the faculty of stereoscopic vision, subserved as it is by a definite muscular mechanism, which permits the estimation of the distance of objects and hence the appreciation of form and the quality of surfaces. By this faculty of vision the artist is given an analytical power which is essential to that just imitation of nature which is a feature (though not the sole ideal) of his work. Stereoscopic vision, however, does not help the observer of paintings, but may rather hinder him.

Another faculty, closely connected with the quality of beauty, is the almost instinctive analysis of objects with respect to symmetry. In nature the property of bilateral symmetry, especially vertical symmetry, is extremely widespread. We see it in animals, in man, in trees, fruits, leaves, and flowers, and in many inanimate objects. So accustomed are we to such symmetry that we lose sight of its importance as an element of beauty. A few simple experiments will convince any one that even the most irregular scrawl attains a certain quality of interest or even of beauty when so duplicated as to form an outline having vertical symmetry. The explanation of this æsthetic quality is to be found in the peculiar arrangement of visual perception in the cerebral cortex, through which each half of a vertically symmetrical object is twice represented in the same perceptual centers.

Visual impressions may be devoid of æsthetic quality, or they may be distasteful, or they may be distinctly agreeable and make the appeal which we designate the beautiful. Few impressions are quite indifferent in respect to æsthetic quality, there being nearly always something in form, color, or composition capable of exciting pleasure in sensitive and trained nervous mechanisms. On the other hand, however low may be the æsthetic quality of a visual impression, it is almost certain to yield to the intellect some information having some grade of value in self-preservation. From this standpoint nothing is

really indifferent, though some kinds of information are far more valuable than others. The perception of physical qualities of objects about us, and the recognition of their distance, are, at any moment, liable to become practically serviceable in protection from injury or in furtherance of an aim.

IV

Sculpture and painting appear to have a common origin in the stone-cut designs of early Egypt and Ethiopia. These designs are strikingly free from suggestions of the sexual element in life, and strongly tend to embody the self-preservative instinct. This is shown by scenes of prowess, of hunting and fishing, of boating, of fighting, of the slaying of captives, of petitions and offerings to the gods. And there are crude symbols belonging equally to sculpture, to painting, and to literature, such as the wavy line used to represent Hapi, the river Nile.

At a later and more refined stage of Egyptian art the softening influence of sex is still unknown. So in the exquisitely colored, if somewhat grotesque, human and animal figures in the imposing tomb of Ceti the First (where the rich red tones are cunningly used to display a pomp and magnificence that is truly regal) we may seek in vain among the aggrandizing compositions for any scene that reflects those human affections that have their *fons et origo* in the attachments of sex. Indeed, in these early days

even the rudest manifestations of sex are suppressed from the chisel pictures and the color pictures with a thoroughness that would win the praise of the Puritan rulers of a New England town. And much the same holds true at the Ptolemaic time, when Cleopatral forms obtrude themselves on temple walls, and the birth houses picture each stage in the drama of a human childbirth. There is little to show that the artist's mind had grasped more than the mechanical and obvious aspects of the sex power. Only rarely do sculptured scenes occur that suggest that the love of man and wife, or of parent and child, is one of the great human forces to be reckoned with. In the days of Greco-Egyptian, Greek, or Roman art sculpture served better than painting to record the charm of sex, and it was not until the days of the Renaissance that gifted painters, yielding to the gentle lead of Christian tradition, gave themselves, at least in part, to the congenial task of portraying the adoration of the Sacred Mother for her child.

The immense popularity of the Madonna and her child has its real basis in the awakening of that human sympathy which springs from the love of offspring, and it is a pity that the legend of the birth of Christ should have been marred by the useful but unbiological myth of the immaculate conception. It is not surprising that the weaknesses of the story, now so obvious to the students of science, should have been overlooked by the multitudes who turned for comfort from the harsh, inhuman attitude of

paganism to the warm, kindly feelings typified in the portrayal of the peaceful tie between mother and child. Since the days of the Renaissance, the art of painting has recognized, more and more frankly, the unsuppressible power of the sex instinct, and has found, in the nude female figure, and to a somewhat less extent in the male figure, the elements of a charm and beauty that have their basis in the fundamental physical and æsthetic needs of human nature. Very gradually, as people have grown more gentle, more cultivated, and more introspective, the greatest pictorial art has come to occupy itself less and less with subjects subserving the aggrandizement of man, and more and more with human relations in which the charm and beauty of sex play always so potent and often so determining a rôle. The humanizing influences of Christianity have had much to do with facilitating this tendency which continues to operate to-day, as we may see in the mural decorations of Puvis de Chavannes, the modern representative of the spirit of Botticelli. But the humanizing lessons of religion have been learned; the beauty child has learned to walk alone, and the art of to-day reflects the kindlier human feelings based on no creed but on a broader appeal to the chivalry and justice of man's nature. And at every turn it is apparent that this growth has its foundation in the emotional expressions of sexual relations and especially those that have arisen in family life.

The development of landscape must be regarded

as a side growth or sub art of painting. Being a recent phase of art, dating back in reality only to the time of Constable, it might perhaps be thought to stand for the most modern Platonic and loftiest expression of the painter. But the beautiful in landscape, whatever it may possess in charm, refinement, and suggestiveness, must always make a relatively limited appeal to the imagination, and in power to arouse emotion and passion must fall far below the art that utilizes the sex charm of the human face and figure. And it seems safe to predict that the future, as well as the present, belongs to that aspect of pictorial art which is most closely in accord with the most powerful stream of biological tendency — that which arouses the deepest feelings of sympathy through the subtle channels of a refined sex instinct, blended with more intellectual appeals made to instincts that have their roots in the somatic life.

Aside from its connection with architecture, sculpture seems not likely to exert a wide influence on humanity, owing to the limitations belonging to its medium of expression which brings a certain coldness into its appeal. In architecture, on the other hand, we have an art susceptible of wide development and influence, where once its possibilities are appreciated and its principles have been learned. It is an art which has greatly suffered through the practical needs which it subserves. People can live without paintings and music, but are compelled to erect

houses and public buildings, and this necessity has very commonly obscured the attainment of æsthetic qualities. That admirable types of civic architecture are capable of exerting a refining influence cannot be questioned, and the intimacy and inevitableness of the contact makes the influence more powerful and permanent than might be supposed. And it is not only in its relation to living men that architecture is significant. Something of the pain attending the disposal of the dead might be mitigated by the substitution of very beautiful and dignified surroundings of the last resting place for the unlovely and squalid conditions that now commonly prevail and add an unnecessary burden and mental discomfort to the lives of the stricken survivors. Some adaptation of the Renaissance of France and Italy to modern needs seems the most likely and logical tendency in the architecture of Anglo-Saxon races.

V

The relatively low value of musical sounds in the self-preservative struggle, and the unlikeness of highly developed music to any habitual aural experiences, have the effect of making music the most detached and abstract of the arts and the farthest removed in its content from everyday experience. These qualities make it the most difficult of apprehension for people in general, while for those endowed by nature with the necessary neural machinery and

by experience with the necessary comprehension, it becomes the most significant and profoundly moving of the arts. Musical faculty to the extent of pleasurable experience from serious compositions is a widespread gift, but one not widely cultivated with seriousness. In some, the pleasure comes largely from a ready perception of certain quantitative relations in rhythm and pitch; in others, this instinctive analytical power is replaced by emotional sensibility; and in others, still, both these faculties are united. We must conclude that the nervous instruments of receptivity in the sense organs and their cerebral connections are constitutionally different in different persons. Great refinement in the receptive apparatus, *e.g.* the organ of Corti, may perhaps determine the nice perception of pitch, while rhythm may be related to the organs of the labyrinth. It is perhaps the close connection of the auditory nerves and nuclei with the nuclei of the vagus nerve that makes it possible for music to arouse such profound emotion, and it may well be true that in different persons these interneural links are not equally close and rich. The vagus nerve is connected with many organs on which well-being depends, and we may fancy that disturbances in these organs may sensitize the central nuclei of these nerves in such a way that they would be overactivated by the stimulation of the adjoining auditory nuclei, and so lead to the excessive emotional response observed in some invalids. The magic manner in which in some persons music domi-

nates all the higher psychic processes is possibly due to radiations of energy from the auditory projection centers in the cerebrum to other parts of the cortex, which may, in this manner, be temporarily inhibited and thus bring about the psychical concentration which music induces.

The art of music, operating as it does in time, is far more difficult to trace in its origin than the art of painting, which, operating in space, may leave us visible and tangible records. We are quite without the means of knowing under what influences the first rude strains, sufficiently systematized in respect to rhythm and pitch to give them somewhat of musical quality, made their way into existence. It seems likely that certain tones of the savage human voice, uttered in response to emotions of joy or triumph or terror or pain, formed the rude basis of somewhat conventionalized sequences of sounds, which though recorded only in some primitively trained minds, could be handed on from one generation to another, thus growing in time, by simple accretions, into tribal or folk songs. It is likely, too, that from the earliest times of musical expression song subserved the emotional side of man's nature far more than painting did, and that, like language itself, the musical art, even in its crudest stages, voiced the many-sided needs and powers of man.

The human voice lends itself with the utmost ease to the expression of emotion, and there is, accordingly, the closest physiological similarity between the pro-

cesses that underlie the musical utterances of song and those that subserve spoken words. There is, in fact, every imaginable transition between the most prosaic of spoken words uttered without regard to pitch or rhythm and the most poetic verbal expressions designed expressly for song. Poetry and music are thus most intimately affiliated in their origin, and the resemblance between these arts extends to their contents. It is equally within the sphere of music and of poetry to be the vehicle for feelings based on the instinct of self-preservation, or on the instinct of sex, or on the fusion of both these primitive instincts, and it seems probable that in a rude way both music and poetry did actually subserve the expression of these instincts at a very early period of the race history. That men used vocal music as a means of self-aggrandizement long before they used it to give expression to the subtle and refined phases of human love, seems as obvious as the corresponding truth in respect to painting. We may draw on the Greeks for examples of this inequality in the expression of somatic as compared with sexually based feelings. Plutarch says of them: "And their very songs had a life and spirit in them that inflamed and possessed men's minds with an enthusiasm and ardor for action; the style of them was plain and without affectation; the subject always serious and moral; most usually it was in praise of such men as had died in defense of their country, or in derision of those that had been cowards. There were also vaunts of

what they would do, and boasts of what they had done, varying with the various ages; as, for example, they had three choirs in their solemn festivals, the first of the old men, the second of the young men, and the last of the children; the old men began thus:—

"We once were young and brave and strong."

The young men answered them, singing:—

"And we're so now, come on and try."

The children came last and said:—

"But we'll be strongest by and by."

Many examples could be given to show that the music of the Greeks was related to the idea of valor and military glory much more than to the refined sentiments of humanity which have their pivot in the relations of family life. And this need excite no wonder, for nothing else could be expected from a nation which made the family secondary to the state, and which was satisfied to permit a large number of its best and most intelligent women to lead the lives of prostitutes. That under these conditions the typical Greek music should be dull, unimaginative, and lacking in ideas is only what might be predicted of any nation, however brilliant, where the relations between men and women are wanting in delicacy and deeply romantic and self-sacrificing attachments. The Greek poverty of instruments capable of express-

ing profound emotion may have contributed in some degree to the thinness of their music, but this poverty is to be considered as a result of the prevailing deficiency in musical ideas rather than its cause.

Just as painting found its great chance in the illustration of Christian tradition, so did music perceive its opportunity in ministering to the devotional spirit that tenanted the Gothic churches of Christendom. The music of Palestrina and of Buxtehude, though unimpassioned and failing to reflect modern introspective tendencies, was admirable in form and served well to introduce the deeper feeling embodied in the classic contrapuntal composition of Bach. The great emotional restraint and noble devotional character of Bach's music give it a stately grandeur which compensates in a degree its lack of freedom in form and variety in emotional qualities — at least as compared with the work of later masters. The music of Bach leans to the intellectual rather than to the emotional side, but just as it is too refined and lofty to reflect any crude aspects of the instinct of self-preservation, so it is too calm in its feeling to arouse, in an active way, the passion of love based in a direct way on sexual attraction. It deals rather with the impersonal and abstract aspirations of man, with broad philosophical or devotional mental states, than with more elementary and personal moods. The music of Beethoven reflects the qualities of a passionate being, less restrained by the forms of art, more desirous of making an appeal,

through the beautiful, to the generosity, the pity, and the affection of human beings. Beethoven's genius has a wider range, a greater inclusiveness than that of Bach. In the *Missa Solemnis* it exhibits a lofty devotional spirit not inferior to Bach's purest offerings to the humanitarian spirit of Christianity. The *Third Symphony* utters an appeal for the liberties of man that has never been equaled in force, passion, or nobility. In his love music a still different and exquisite phase of Beethoven's power is revealed. If history speak truly, the naïve and simple song which bears the name of *Adelaide* was the vehicle by which the great musician expressed a deep personal attachment. In this song, as in others, Beethoven shows us how seriously, with what romantic idealism, he regarded the attachments that spring up between the sexes. His music, though full of sentiment and tenderness and often tinged with the deepest pathos, is never morbid or depressing, but rather joyful and stimulating to unselfish acts. This healthful tone was caught also by Schubert and is recorded in that astonishingly long series of songs devoted to themes of love that flowed so spontaneously from his pen. Robert Schumann, inspired by both Beethoven and Schubert, mingled with the qualities which he derived from his masters an exquisitely refined and beautiful pain sense, which, though verging at times on the psychological, is, upon the whole, healthful in tendency. This complex æsthetic quality, so essentially modern in its

introspective vein, when translated by Schumann into the music of love, resulted in the creation of the most poetic, most intimate appeals of quivering consciousness for reciprocity in an attachment of the most ethereal and delicate quality of which a sexually founded passion is capable. A very similar type of poetic achievement in music is to be found in the love songs of Johannes Brahms and of Richard Strauss. In neither of these composers is there to be seen the same degree of spontaneity of utterance as in Schumann, while in both there is a highly individual attribute of modernity which arises from a refined but sometimes somber self-scrutiny in respect to emotional experiences. But it is significant of the marvelously subtle and varied possibilities of erotic feeling that these newest exponents of a fundamental human passion should be able to stir emotional depths hitherto unsounded and sometimes terrible in their beauty pain. And any mention of modern tendencies in the music of love would be glaringly incomplete without a reference to the very different emotional response that may be counted on from the ingratiatingly sensuous, semisensual music of Wagner, as one may hear it, for example, in *Tristan and Isolde*. The wonderfully continued summations of stimuli ending in climaxes of great emotional intensity and exquisite beauty derive their significance from the universality of their appeal, from the fact that they elicit a keenly pleasurable sensation from so many different nervous systems, at

least during the adolescent and early adult periods of life. These sensory and emotional experiences are, in general, on a far lower plane than those more subtle responses excited by the music of Brahms, in the sense of being dependent on simpler elementary feelings of passion less mixed with the highly pleasurable pain sensations that spring from the arousing of impulses of self-sacrificial nature — impulses always demanded by the least selfish form of love.

What has been said suffices to show that a not insignificant phase of the productivity of the representative masters of modern music has to do with the amorous side of human consciousness, and it cannot be gainsaid that this has its origin in the sex instinct. A recognition of the refinement and nobility of the feelings that have given birth to much of this music must not blind us to its essentially sexual origin. Such feelings may be and doubtless often are wholly distinct from any indulgence even remotely verging on sensuality, but they have their basis as definitely in the cruder necessities of sex as the refined tissues of the nervous system have their parentage in the primitive vulgar epithelium of the skin. It is unphilosophical for us to lose sight of the biologically humble ancestry of our artistic feelings, and to deliberately close our eyes to it is a process of intellectual snobbery comparable to the spirit that encourages a rich bank director to forget that he was once a laborer on the docks. But it is not merely the music of love that can be traced to this relatively humble origin.

There is much to indicate that religion itself has one of its firmest and deepest roots in the instinct of sex, and if this be true, it follows that even the most elevated devotional music is founded in some measure on this instinct.

VI

The drama with its complex double appeal to the eye and the ear offers ways of making profound impressions on the human nervous system, and on account of this varied expression is perhaps capable of reaching effectively more kinds of nervous organizations than any of the more elementary arts. It were, indeed, an insensitive and ill-formed being who should find nothing of response within himself to a well-presented Hamlet or Camille. And it is just this wealth of appeal in which nearly every kind and shade of human trait can be exposed to the mind's eye and ear which gives the drama its great biological significance, its power to mould slowly or quickly, the reactions on which the conduct and opinions of individuals depend. We may say that the abuse of the drama is one of the most serious defects in civilization, while, on the other hand, its embodiment of the highest ideals is one of the greatest levers for progress. Good taste and discrimination in drama must come in part from exposure to the influence of the best plays rendered by the best actors, but the effectiveness of this mode of appeal must depend in

a high degree on education in other directions, in actual human relations and in literature. In other words, the type of human education, in the large sense, will influence the nature of the demand for dramatic performance more than this can influence education. But it is not unreasonable to hope that with the years there will be a powerful growth in significant dramatic influence, capable of modifying in important and ameliorating ways the conduct of larger numbers of people than at present. Probably it is the emotional effect — the effect obtained through human speech, modified by the presentment of human action — which chiefly accounts for the intensity of the dramatic influence, and this influence may be exactly appraised by comparing the effects of the play as read or acted.

While the completeness with which the drama represents human situations is one measure for the efficiency of its appeal, it is yet evident that some loss in simplicity, purity, and depth of artistic stimulus springs from this commingling of multiple visual and auditory impressions. There are sentiments so large in their conception that we can best feel and understand them when presented to us in the simplest settings. We see likewise this loss in simplicity and directness of appeal where the musical drama is used as a vehicle of artistic expression. The noblest music loses when harnessed to words expressive of quite definite ideas or when associated with a definite set of human actions, for the reason

that such music is by itself sufficient to completely absorb the attention of even the most cultivated and analytical ear. The simultaneous appeal to the visual sense means division of attention and a dilution of the deepest auditory effect of which the music is capable. This appears to be the experience of the most gifted musical persons and apparently rests on definite laws governing the expenditure of the energy implicated in the maintenance of attention. It may be successfully contended that music is not at its best when serving the drama, and there appears a sound biological basis for this contention. And we may go so far as to hold that music illustrated by words departs from the lines of greatest purity of appeal by introducing an attempt at definition which, at least in some of its greatest examples, may better be left to itself to work its full effect on the imagination. We cannot, for example, conceive of any poem or drama which would not rob the later Beethoven quartets of something of their profundity.

VII

If we look at literature in its relation to the fundamental somatic and sexual instincts, as we have already glanced at painting and music, it quickly becomes obvious that the relation is more intimate and springs into view more spontaneously than in the case of either of these other arts. The reason for the greater obtrusiveness of the roots of literature is to

be sought in the greater simplicity of the medium of literary expression. So great are the technical difficulties relating to music that the development of the art was greatly delayed by the necessity for mastering these, and to this day it remains the medium in which the fewest artists are able to work with success. Painting also demands highly special technical conditions, which make it relatively easy to meet with measurable success, but extremely difficult or impossible to ideally satisfy, owing to the poor control that even modern artists possess over the lengths of light waves as compared with control over the lengths of sound waves. But literature uses a medium that makes lesser demands on the technical ingenuity of a race than either painting or music, and hence we find many nations that have left respectable verbal records, but neither musical nor form-color traces. So it has come about that we have in literature far more complete evidences of the causal nexus with the basic instincts through a long period of time. Nevertheless, the literatures of ancient peoples are so incomplete as to give us only an occasional glimpse into their dominant thoughts. But from these glimpses we learn that in literature, as in music and painting, the expression of the somatic instinct precedes and overshadows those based on sex. The oldest Egyptian writings consist of appeals to the gods, of directions for achieving salvation, of boasts about personal prowess and conquests. Occasionally, as in the "Egyptian

Tales," there is an allusion to affairs of love and even an intimation of some refinement of feeling in the relation between man and woman; but these are very exceptional utterances, and the idea of self-aggrandizement in this life and in the next is everywhere dominant. The Homeric poems taught "discipline, arms, and equipment of war," and reflect man's love of himself and his infinite capacity for brutalities of all sorts. The nobler forms of attachment between the sexes do not seriously burden the poet. Penelope was certainly patient in waiting for Odysseus, and Andromache appears to have been pained to part with Hector, but there is no reason to believe that this devotion was anything but one-sided, the man being bent on the pursuit of what he thought to be glory. Plato had the intelligence to see that a state could not be strong where its women were so undervalued and insulted that they suffered in physique from the neglect to which they were subjected; his advocacy of their rights rested on practical rather than sentimental motives. The sympathetic and understanding attitude of Euripides toward women (as shown, for example, in his Medea) but serves to emphasize by contrast the universal predominance in Greek literature of the self-glorification of the male. There is nothing to suggest that the sex instinct had developed in men and women the finest traits of personal devotion. The same hardness, due to the mastery of the self-preservative instincts, is seen in the Old Testament. Christ

brought an old force newly into play — the humanitarian sympathy that leads the strong to protect the weak and that recognizes the infinite superiority of the spiritual over the grossly material elements of life. In battling for the ideal of human sympathy he fought unconsciously for the development of the refined manifestations of the sex and racial instinct as opposed to the brutal tendencies of self-aggrandizement. Despite the perversions it has suffered, this Christian ideal has been kept alive by the nations of Europe, especially by their poets and religious teachers. The history of civilization in Christendom has been a record of broadening sympathies, moving hand in hand with rising intelligence. Literature clearly reflects the growth of this humanitarian spirit. Now if we analyze from a biological standpoint the underlying civilizing forces that have been at work in Christian countries during the past two thousand years, as they are revealed in the literature of the dominant modern countries (France, Germany, England), we see that progress has been attended by a growth in those qualities that spring from increasingly intelligent affection, devotion, and self-sacrifice between the sexes. The improvement in relations between parents, and between parents and children, has been attended by meliorations between persons unrelated by blood, but related by ties of temperament and sympathy, and finally also by the betterment in the attitude of men and women toward the unknown multitudes — in other words,

a broadening of interest in the entire great human family. Underlying this enormous gain is the fusion of the primitive sex impulse with the essentially self-preservative impulse on the part of each sex, to acquire knowledge of the other sex. Higher sexual interests have thus become based on lower and more primitive ones, and this growth has had an immeasurable but powerful effect in checking some of the savage impulses that come from the unbalanced exercise of the most elementary somatic instincts. Literature clearly enough reflects these tendencies, which are associated with the same slow-going inclination to self-examination that is notable in music, and that began during the Renaissance and Reformation. The sonnets of Petrarch, the verses of Dante to Beatrice, the erotic sonnets of Shakespeare, so pregnant with biological understanding, all reflect the awakening of the higher sexual feelings and emotions often attended by the half-pleasurable pains of introspective thought.

And if further testimony were needed to show the greater refinement of understanding and feeling that pervades modern literature in its delineation of the amorous passion, it is to be had in the poems of Goethe, of Heine, and of Browning, in the plays of Alfred de Musset, and in the revolutionary idealistic writings of George Sand. Society is also indebted to Mr. Bernard Shaw for a physiological interpretation of many sexual manifestations that arise from the somatic instincts. For while Mr. Shaw's views

are often expressed with more regard for the witty than for the true, they are to be commended in general for their frankness and soundness.

The ability of the race to record easily the symbols of verbal expression — language — in such a way that they can be recognized and conveniently revived by persons who have never before seen them brings with it a new and unique possibility. This is the power conferred by such records on an individual to acquaint himself accurately with the thought of many other persons, not only in the present, but in the past. Such a power not merely enormously increases the knowledge of an individual, but also furnishes the materials for wide and safe excursions of imagination. The possession of a literature becomes the most powerful means of elevating man in culture and in intelligence. During the greater part of the time that human records have existed only the few have benefited by them. Nevertheless, they have served to keep alive a slender but important stream of human lore until such time as the ingenuity of man devised movable types and the printing press. With the spread of printed matter came the first great step in the modernization of the world, the popularization of the opportunity to learn mainly through education of the visual mechanism, and less directly of the auditory centers. But the wisest development does not necessarily center about the invention that brings facility of performance. It is well understood that in science there are

drawbacks to the buiding up of researches around new apparatus. The cheapness of printing and the ease with which newspapers are disseminated has led to the popularization of the trivial, the vulgar, the criminal, and has in a degree poisoned popular taste. It is, however, a law of nervous action that overstimulation of any receptive neural mechanism leads to fatigue and often to disgust, while at the same time tending to render the mechanism more sensitive than previously to contrary influences. The law probably holds good of emotional stimulation as well as simple sensory excitement, and just as the eye overexposed to yellow becomes sensitized to purple, so must the mind in time, wearied with this sensationalism and falsity of the newspaper press, become more aware of the satisfactions to be gained through the opposite qualities. We may, therefore, expect to witness reform following sensationalism.

In the higher fields of literature, in criticism, fiction, poetry, and philosophy, the ease of printing the results has had a better influence, though, as in fiction, not an uniformly good one, since there has come into existence a great mass of writing without claim to merit of permanence. But the laws of competition and survival are acting here, and there is everywhere in literature evidence that the public is growing educated in ideals as well as in knowledge. A portion of the community has begun to think critically. It demands from poets and novelists some justification for writing, some evidence of originality in thought

or method, some improvement over earlier achievements. Certain standards of judgment reflect clearly enough the modernity born of science, especially in its biological aspects. Emergent from the most varied judgments is the growing tendency to place a higher and higher value on truth. The criteria as to what constitutes the truth have been largely modified by the teachings of science, and literature is unmistakably feeling the influence of this alteration in standards. The effect is visible both in fiction and in poetry. The modern concepts of the universe, and especially the evolutionary conception of man, have greatly added to the difficulty of writing a superior order of poetry, since these compel the abandonment of too crude notions of an anthropomorphic or mythical sort. On the other hand, it requires a lofty and noble handling of the large themes of nature to secure a reasonable conformity with the spirit of science without yielding to an embarrassing precision of detail fatal to poetic fancy. That there will one day arise a type of genius successfully expressive of the poetry of the play of celestial and human forces seems probable. Goethe, Browning, and Emerson have entered this nonfacile territory, and Shelley has worked his rich imagery into its margin in his inspired groping toward the light of truth. That the orderly plays of energy, as seen in ions, in living organisms, and in the mechanics of the universe, are inspiriting themes for poetic expression is obvious, but it is equally clear that some of the mythological

and anthropomorphic imagery that has served so well in the past will hardly continue to pass as poetic coin without some revision and recasting. It is possible that blank verse may be found a more fitting medium than rhymed verse for the expression of such modern conceptions of the large play of forces.

In fiction, too, there is an unmistakable trend toward verisimilitude. Fiction as a form of literature plainly exposes the limitations of the human mind in respect to the understanding of other human minds, for it makes a strong call on imagination, and often the play of fancy is shackled only by the necessity of conforming to truth sufficiently to evade the offensively grotesque and the ridiculous. The novel is still too young to make it possible to predict whose works will longest command the time of cultured readers, though it seems old enough to have established itself as a literary form. Many types of elaborate neural organization are represented in the experiments of the word painters of human story — the exaggerated emotionalism of Dickens, the calm analytical power of Eliot, the kindly critical reactions of Thackeray, the essentially penetrating mental vision of Turgenev, the direct polarizing prismatic vision of Henry James which regularly deflects the emotional ray to permit only the emergence of the extraordinary. The great story-tellers are intuitive psychologists, and the hold of their writing depends far more on their understanding of the human mind than on any incidental descriptions

of scene or place. The fictional arena is a wide one, inviting to all grades of talent; and if it seems too crowded with mediocrity, it is consoling to know that here, too, the law of biological struggle and survival is active, and must shortly clear the field of all but the presenters of the truth which the world is learning to demand in more and more refined form. If an intense realism prevail for a time, it should excite neither wonder nor apprehension for the fate of the novelists' art. For such realism is needed, by many at some time, by some at all times, to hold the mirror of record to the complexities of human action, and to help to free them from confusion. The guarantee that the idealized versions of thought and conduct will triumph ultimately lies in the fact that the human mind tires of the simply photographic and delights in emphasis of the tendencies and meanings which can only be elicited by the art of sane idealization.

VIII

In the foregoing sections some reasons have been adduced which show that in painting, in music, and in literature we have human products that represent the fusion of self-preservative and sexual instincts. It is not difficult to produce evidence that a fusion of these instincts is also perceivable in the religious activities of the human mind. All forms of religion have at least two kinds of devotees: those that are chiefly interested in the outward signs of religion,

and those that are attracted mainly by the spiritual or devotional qualities of their belief. The motives that animate the former class are usually not highly complex, and need not concern us here; but the basis of the truly spiritual devotion is much more obscure, and should not be overlooked in any examination of the primitive biological factors that enter into mental states. For our purpose it is not necessary to discuss the probable historical development of the earliest forms of religion. It is sufficient to note that all primitive religious ideas probably have their foundations in the desire to get material aid from superior powers. The god is called upon for food, for success in battle, for help against evil spirits and fearful things, and probably not for spiritual aid in the elevation of character. Every popular religious belief apparently crystallizes about some definite material need or group of needs to which may be added later more abstract wants. The varying conceptions as to the nature of the ruling power or powers, found among various peoples and in different ages, are purely arbitrary expressions of a striving to make tangible and distinct that which all have vaguely or more distinctly felt to lie outside the grasp of human intelligence. Now these symbols of power which men have invented or selected from natural objects for purposes of adoration have been consciously or unconsciously selected with reference to individual needs or racial needs. These needs represent both the somatic and the sexual instincts,

and are to be recognized, if sometimes with difficulty, even in the most purely devotional mental states of modern Protestantism. To those who like to regard the religious instinct as something wholly separate from thoughts, feelings, and emotions of obviously bodily origin, this analysis of devotional states into something more primitive is likely to be distasteful. The only reasonable basis for such a distaste lies in the assumption that there is something ignoble about the elementary natural phenomena, a position which is not acceptable to the philosophically minded biologist.

CHAPTER XII

EDUCATION AND THE FUTURE OF THE RACE

It is self-evident that whatever may be the moral or intellectual aspirations of a nation or race these can be achieved and secured only by maintaining a reasonable level of physical vigor. In special cases a considerable degree of mental power is compatible with a feeble body, but, in general, the old observation "mens sana in corpore sano" holds good. At present the bodily state of the Anglo-Saxon race is being influenced strongly in two opposite directions by a condition incidental to modern civilization. On the one hand, the science of living has improved so much as to make it possible for those with knowledge and self-control to better their chances of keeping vigorous bodies; on the other hand, competition is increasingly fierce in business, and a larger proportion of population is all the time accumulating in the large cities under conditions that make out-of-door life more and more difficult to obtain. If we judge by studying the death rates and the expectation of life at different ages, it is undeniable that in the past fifty years there has been a growing tendency to prolong life. Prolongation of life perhaps means increased vigor, but not necessarily,

because the gain in life may be due in a large degree to better methods of preventing the spread of infectious diseases, or controlling them when they have gained a footing. It is extremely difficult to prove that the average physical vigor and efficiency of the population are actually heightened by a decrease in the death rate, but it is likely that there is some change in this direction. The effect of the generally improved hygienic surroundings is being neutralized by the increasing proportion of people who live in large cities under unfavorable physical conditions. An illustration of the deterioration arising in a great city obtruded itself on London during the Boer War, when it was found that a surprisingly large proportion of the offering recruits were physically unsound, not so much from definite disease as from various forms of underdevelopment and feebleness due to malnutrition. Though it is difficult to predict the outcome of these warring tendencies for good and evil upon the health and efficiency of nations, one important fact is nevertheless clear: the ultimate result is largely in the control of the individuals that make up the community. Never before has it been possible for the citizens of a country to exert so telling an influence in the right direction by the intelligent exercise of will power, since the knowledge of what makes for health and strength is to-day fuller and more accessible than at any previous time. Moreover, local and central governments are everywhere awakening to the necessity for intervening in

various practical ways to protect people against the more obvious causes of infectious disease. But mere knowledge of the causes of disease on the part of the people and wise health regulations on the part of the government will not necessarily suffice to improve the average bodily efficiency of the members of the community. To secure this it is essential that there should be intelligent and continued efforts on the part of a large percentage of the population to practice self-control in regard to many habits of life that cannot fall within the scope of even the most paternal government. The physical health of the human race is, in a remarkable degree, under the control of the people themselves. There can be little reasonable doubt that a far more hardy and enduring race is capable of deliberate development. It remains to be seen whether the individuals who constitute nations will make the necessary sacrifices to bring about this improvement.

The theory of evolution indicates that man emerged in distant times as the king of animal forms after a long period of development in which all competitors became gradually separated by an immense gap. The lead so gained over other animal life is so great in respect to bodily structure and mental endowment as to make it unthinkable that man should ever be displaced by forms descended from types now inferior to him. The developmental contest is now one between different races of men, and it is evident that certain nations, especially the

Germanic and Anglo-Saxon, have gained a material advantage over other nations. This advantage is the product of numerous factors, including physical vigor, powers of reproduction, intellectual power, and ideals of life. Although at present the supremacy of these races is not threatened by other races, the maintenance of this supremacy cannot safely be viewed as a permanent asset of any group of nations. The qualities that secure dominance to modern nations have been somewhat modified by the conditions of modern civilization, and there is every reason to think that the modifying processes now in play will long continue operative. Supremacy still depends on the likelihood of waging war successfully against rivals, but this element is no longer so prominent as it was. Success in commerce, rather than territorial or political gain, is now the goal of competing nations, and this type of success depends upon industrial productiveness more than on warlike qualities. The success of industry depends on scientific knowledge, on ingenuity in applying this knowledge, on assiduity and intelligence in technical work. These are qualities that call for a different training and different ideals from those of military life. Factory life makes greater demands on physique than life in the barracks, and when unregulated, is capable of lowering the physical vitality of the nation. Yet the conditions of factory life are in general so controllable as to make the maintenance of physical health possible, even where workmen are

exposed to poison, as in the case of the color works in Germany. And it is probable that nations could pass from a militant condition into a condition of greater and greater industrialism without any material sacrifice of physical vigor.

The bodily welfare of nations is of interest mainly in its relation to their mental and moral growth. It is certain that under more favorable social conditions nations would be capable of extending a higher grade of culture to a far larger proportion of the total population than at present. Although the desirability of doing this is questioned by some, there is surely no excuse for withholding from people their chance of self-development or any part of that chance that may fall to their lot. Every human being has the right to cultivate his powers to the highest point he is capable of reaching, so long as he does not interfere with the right of other people to do the same — a kind of interference about which the world hears fierce complaints. And we may confidently expect the leading nations of the world to increase their commercial and political influence by the general extension of educational opportunity to the masses. That the minds of all classes but the very lowest are susceptible of far greater training than at present, both intellectually, emotionally, and æsthetically, requires no argument.

But the civilization of a nation does not acquire its distinctive character from mediocre minds. Saint-Simon, the socialistic philosopher, long ago

pointed out the dire consequences that must result for France should her chief thinking and productive men, engineers, lawyers, physicians, scientists, — a small number, — be removed from the kingdom. At the same time he incurred political disfavor and was banished for suggesting how easily the country might dispense with the services of an equal number of courtiers, nobles, and royal personages. There is no doubt as to the reasonableness of Saint-Simon's main contention that the leading minds of a country, the minds which determine the lines of progress, are relatively few, and that the loss of this intellectual aristocracy would cripple any community for many a year. Our interest thus focuses on this upper stratum of minds when we undertake to picture the future mental powers of our race. Is it possible to increase the capacity of the human mind by the processes of evolution? Is there any evidence that the best minds of to-day are superior in quality to the best minds of the earliest historic times? Unfortunately the data at command do not allow the formation of a wholly satisfactory judgment on these questions. If it be true that man has evolved from lower forms of animal life, mental evolution must have been a feature of this upward progress, but when we try to compare the best minds of the present day with those of a few thousand years ago, we are confronted by serious difficulty in making any reliable comparison, mainly because it is impossible to represent to ourselves similar minds operating

under conditions so different as those of to-day, and those of the period of the Rameses or of Alexander. The great superiority of the conditions of to-day for mental development gives us the impression that the best modern Germanic minds show more capacity than the best Teutonic minds of the times of Suetonius. There is, however, no proof that this is really so. We can merely guess and hope that in the general tendency of man to ameliorate the brain has had its share. The improvement in the general level of intelligence should not make us overconfident of the growth of maximal understanding. If there be a tendency toward the betterment of the lowest minds, that is, of those least able to voice the feeling of the infinite and abstract, it is at best a slow and hesitant tendency. We have no right to assume that the mental and moral progress of any nation must continue. The best minds of any race may grow less numerous in response to decadent physical changes liable at any time to assert themselves; and this lowering of the highest levels would be apt to coincide with a decline in the general level of capacity. But it is reasonable for us to take an optimistic view of the possibilities open to the human mind, to believe that at least some races, by struggle and self-culture, may conserve and develop natural powers in their chosen few, distinctly superior to any that have yet left their record in the world. Our conception of the universe is limited by the restrictions of the most capacious and intuitive minds

that have yet been our teachers. May we not hope to deepen and extend that conception through the medium of still better nervous systems than any which have yet been produced?

If it be true that mind is a function of the refined type of matter which we call nerve tissue, the central problem for man is the care and development and intelligent control of that precious and infinitely complex substance. In the language of physiology the legitimate aim of the race is the education of the highest nervous centers of the organism that subserve consciousness. All other aims are secondary and base. Nature has been lavish in its supply of raw material, but man has been wasteful and careless in his use of the big opportunities offered by her. Only sporadically have there appeared centers of systematic effort to utilize the possibilities of mental and moral growth, such as the churches and the universities. Fortunately every family and every aggregation of men is, in a sense, a school, and the world knows that genius has repeatedly appeared in the midst of disorganization and poverty, and well knows that this will continue to the end of time, since genius is in the biological meaning of the word a "sport" unpredictable in the conditions of its emergence. Yet the organization of the school and university is an enormous stimulus to talent, and even genius cannot wholly dispense with this aid, without at least some loss in energy.

It appears superficially as if nature were even

more unfair in the distribution of her natural gifts than is really the case, and looking at the mass of unendowed humanity, the philosopher may be hard-pressed for an explanation and justification of so many lives of so little promise. But there may be discerned in these masses of men and women some elements of compensation and grandeur in the larger uses which they subserve. For are they not the material from which talent and genius are recruited, at least in large degree? The wealthy and fortunate classes, having appropriated the ordinary prizes, are off their guard at least to the extent that they relax in the developmental struggle to which they owe their success. Their children are likewise disarmed in the silent competition of mental ascendency. The hard-worked people, of modest or unrecognized abilities, inured to daily sacrifices, under the unrelenting spur of necessity, are culture media for human selection. In this wise do the humble make their contribution to the progress of the world's aristocracy of nervous systems, a few great minds being always in process of emergence from the undistinguished masses. For these human contributions they are repaid by the help they derive from the great men they have helped to raise. And so the cycle repeats itself — the few of great gifts leading and elevating the many, the many contributing to replenish the small ranks of the greatly gifted who have learned to use their gifts.

The problem of education is humanity's greatest

problem, as it always has been and always will be. Modern society, rendered more and more self-conscious and analytical through the intervention of science, is growing slowly and very certainly to recognize the gravity of its problem. Very slowly, too, it is learning to solve it, not as a problem in its entirety, but fractionally, one-sidedly, with much painful experimentation, with many rebuffs, and a few permanent successes. If it be true that the future of any nation may be profoundly influenced for good or for evil by the deliberate strivings and aims of its people, it must follow that these strivings and aims afford at any period a reliable index of the general trend of progress or regression. So, too, if we would give direction to human progress, we must do so by the slow and moulding processes of education of the nervous system rather than by the superficial and time-serving legislation to which resort is often made for the purpose of correcting evils or evoking virtues. But the mass of any nation is made up of persons little given to thought, eager to secure quick results, impatient of the slow methods of nature and education. They are thus a ready prey to the quackery of legislation as to the quackery of drugs, as we see only too plainly in democratic countries, where the ignorant and the intelligent, the vicious and the good, have votes of equal value.

If the processes of education were simple and easily apprehended, educators and philosophers would doubtless have succeeded better than they have in

their efforts toward uplifting humanity by enlightened training. But these processes are complex in a degree commensurate with the unparalleled complexity of nervous functions, and hence both theory and practice have been laggards, and the wisest of men have studied the educational task one-sidedly and without agreement among themselves. And so long as men differ in temperament as well as in powers of apprehension, they will differ in their recommendations as to what we should strive to attain in education and as to the means of attaining every worthy end.

In thinking of tendencies it has seemed to me that we have too much neglected some obvious suggestions given us by Nature herself. The educational suggestions to which I would draw attention have their basis in the biological substrata of our nature — in the differences between the self-preservative and the sexual instincts. The recognition of the needs of developing human nature involves an insight into these different biological springs of activity and function. Has not this insight and understanding been too often lacking in the minds of educators, and has not this led to confusion and obscurity in considering the aims and methods of education? We must not try to make an absolute separation, since Nature herself fuses these instincts, but shall we not learn to trace and understand and nurture them separately?

The line of development of intellect is suggested by the line of progress in a savage, *i.e.* qualities are

cultivated that aid in self-preservation. Even in civilized life this line is paramount, for the chief activities of the man and woman are expended in the direction of maintaining self. What qualifications are needed for this? Mainly observation, accurate and quick, good memory, power of generalization sufficient to distinguish between that which is favorable to self and that which is not; this is partly an instinctive faculty, partly acquired, but it can be acquired to a high degree. Ingenuity in adapting means to an end is a prominent feature of this self-preservative development. Even in civilized men the qualities sought for success are not so different from those of the savage state. The development of observation, of memory, and of the power of generalization for the sake of increased *personal satisfaction* is at present the aim of the few; but there is no reason why it should not become the aim of many more as the interest of society turns more and more strongly towards self-improvement — not for mere self-preservation, but for other purely selfish aims. The motive for this improvement is apt to be in part contributed by certain elements of sexual origin which we may consider later. It is sufficient to consider here, very sketchily, some aspects of the power of observation, memory, and the faculty of generalization, without special reference to the uses to which they are to be put — whether they be of the higher or lower sort.

The ability to observe is a power which grows by

use from infancy to old age, and is limited mainly by the fatigue or the physical imperfection of the senses. The capacity to observe is not the same in all persons, for some persons are endowed by nature with finer and quicker receptive mechanisms than are others. We all remember the celebrated case of Robert Houdin, the French prestidigitator, who systematically trained his son to note with great rapidity and accuracy large numbers of objects, exposed in shop windows, in rooms, etc. The response of the brain to this method of training is something astonishing, and all children should have some training of this kind, although it is only rarely advisable to push it to the extreme sought by Houdin. Very intelligent persons overlook much that is of interest and often of real importance to them simply from defective training in observation, and it is certain that teachers would do well to attach more importance to helping pupils to note more of the objects with which the world fairly bristles. It is not in order to use this faculty on all occasions that it should be acquired; it is to have it at call as a means to an end, or as a pleasure in itself. Some persons with excellent powers of observation may prefer to be occupied with their thoughts; if they do not observe, it is because they prefer not to, not because they cannot. And it cannot be denied that the ability to inhibit observation at will is as important to the educated man or woman as the faculty of highly trained observation.

If we admit the importance of a systematic habit of observation in education, it is plain that the admission brings important conclusions and extensions with it. The child may grow skilled in noting the main features of common and complex objects — the contents of the shop window, the styles of architecture, the needs and habits of dogs, and the forms and colors of flowers. Yet none of these things is sufficiently simple and elementary to be satisfying and educationally adequate. The growing mind must become acquainted with more elementary materials and objects, with water, ice, air, coal, iron, etc.; must learn their properties and must learn to measure and weigh. In other words, the basis of observation should be, in part at least, of such a nature as will involve manipulation, and this use of the hands to subserve accurate observation, when combined with memory and reasoning, may be so extended as to make the introduction to the art of experimentation in elementary physical science.

It is neither a harsh nor an unjust criticism to say that the place which should be occupied in education by accurate observation is now occupied by arbitrary acts of memory. For memory, so active and cultivable in the young, is still the main reliance of the pedagogue, sometimes the exclusive reliance. The young scholar is plied with books. Spread before him is a vast array of facts, to be learned definitely, arbitrarily — the rules of grammar, the conjugation of verbs, the position of dots (said to indicate towns

and cities) on maps, innumerable dates relating to kings and perhaps their mistresses and to unintelligible wars, many a line of poetry, half apprehended, many a rule of arithmetic or algebra, not at all understood. I will not say that arbitrary acts of memory are not necessary to the training of the scholar. No one can hope to acquire the multiplication table by an entirely rational and experimental process, or correct English without some pure grind of memory. But it is fair to say that there is far too much abuse of the powers of memory in childhood for the purpose of inculcating unrelated and ill-assorted facts. This abuse means pedantry, the nature of which, expressed in the terms of psychology, is the accumulation of mental impressions with deficient associations. The reason for this educational practice is plain. It is much easier to secure the sort of pedagogic talent that can teach from a book where everything is put down in black and white than to teach from objects. To teach from objects calls for ingenuity and adaptability on the part of the teacher, and these qualities are not easy to secure. Sooner or later the parents of children will demand these qualities, and the managers of schools will see the necessity for supplying them. Some arbitrary memorizing cannot be excluded, but its extent can be greatly curtailed. The change to more rational objective methods will be welcomed by pupils; and the teacher will find many supposedly dull scholars more apt than he had thought them.

For the development of intellect, it is necessary that observation and memory be vitalized by reason. Without the power of linking facts by seeing relations between them the man of learning remains barren. As a mere repository of information, he must always remain inferior to even a mediocre encyclopedia. The schools have always laid too much stress on the value of facts, and too little on the paramount necessity of correlating them and thus making them serve the purpose of leading to new conclusions and fresh points of view. The universities and professional schools share this fault with the primary and secondary schools. The difficulty in securing teachers who can educate in the sense of teaching their pupils to think for themselves has always been great, and the reason is obvious. The capacity to see facts in new relations means originality and soundness in thought and the ability to see the trend of events. The men who possess these qualities in high degree are either attracted to the active walks of life which promise large material rewards, or they seek the opportunities for research. In either case they are apt to be repelled by the routine of teaching, and either do not teach at all or teach somewhat grudgingly. Sometimes a man of superior ability with a love for teaching remains a teacher during many years, but the number of such persons is always far too small for the needs of the rising generation. There is considerable truth in Shaw's cynical remark, "Those who can, do; those who can't, teach."

The long controversy as to the relative merits of the scientific and classical studies as training for the intellect is not yet closed, and perhaps never will be, since temperamental leanings govern the tendencies even of pedagogues. The partisan of the classical training sees in the Latin and Greek languages, with their intricate grammars (forcing as they do a synthetic and constructive attitude of mind), a stimulus to the development of logical methods of thought. The advocate of the scientific training urges the necessity of pursuing studies that deal with the relations of numbers and with the observation of natural phenomena and the properties of matter. Culture and valuable training may be got through either the classical or the scientific channel. There is, however, a radical difference of quality which cannot be overlooked. The mind of the classical student, while engaged in acquiring technique, is bent on the study of intricacies invented by human ingenuity. The mind of the scientific student, on the other hand, is focused on Nature herself. The study of declensions and conjugations and the relation of the parts of speech affords an admirable discipline, but it represents arbitrarily created problems. The mastery of the difficulties of syntax and grammar throws no light on the methods of nature and is, therefore, no preparation for the understanding of life. But a knowledge of the material universe, of the common properties of matter, and of the forces everywhere in play is the basis for an insight into the occurrences

of which daily life is made up. For the reason, then, that science brings us nearer to nature, the training of the child in the elements of science is to be preferred to the training in the classics as a help to dealing with the realities of the living world. It is no rash prophecy that people will grow to see this more and more clearly, and that an increasing preference will be given to the direct study of nature and especially to physics and chemistry with so much mathematics as is necessary to make the elements of these sciences intelligible.

It will be seen more and more clearly that in the training of the intellect the three cardinal objects are: observation, memory, and the welding power of reason. The schools of to-day rely mainly on memory; the schools of the future will summon to their aid observation and practice in inductive and deductive reasoning. On this power of reasoning the faculty of judgment depends, and on the exercise of this faculty hangs the maintenance of life and the productiveness of the mind. Before a school can become truly educational it must develop in the highest possible degree the ability to lead the scholar from the facts he has observed and remembered to larger facts as yet unknown to him. In this process, which must become a habit of mind, lies the spirit of research.

It will be said that research is for the few and not for the many; that the ordinary scholar has naught to do with the spirit of science. But while it is true

that the number of highly trained research scientists will always be small, it is a grave and costly error to maintain that the spirit of research is not possible or desirable for the many. For it is true that no two lives, however humble, are alike; that every man must face and solve his individual problems. For him the spirit of research will be a help in solving those problems by making him far more intelligent and adaptable and self-controlled than would otherwise be the case. In order to be of real service, the spirit of research must have become a habit of mind, and this can only happen where there has been sound training in the elementary data of science, and in generalization from them. It is hardly to be expected that such training will ever become the privilege of the mass of the populace, but there is every reason to think it will in time be extended to a much larger proportion of the population than now receive it. The benefits of such training will be not merely the better development of intellect, but the fuller growth of character. Where it is possible for a child to have the advantage that comes from a classical training, this should certainly not be excluded; but, in general, where a choice has to be made between the scientific and the classical, the former is to be relied on as a superior guide to the unraveling of many of the perplexities of life.

It may happen that the training of the intellect is so conducted as to make this education an efficient help in most of the relations of life that have to do

with self-preservation. It may teach the care of the body and may render it easy to gain an ample livelihood, or its benefits may extend beyond the consummation of the self-preservative instinct as in leading to discoveries in science or useful inventions or improved methods in finance. But there are other phases of development that may be little affected by the education of the intellect, however admirably this may have been accomplished through the training of observation, memory, and reason. The emotional side of a nature may lag behind, despite the growth of intellect, and, in general, those activities of the mind which have an intimate relation to the sexual or racial instinct may be relatively unutilized. This retardation or arrest of the development of one very important aspect of human personality may give a one-sided character to the nature of an individual. I do not hold that it frequently happens that there is an extreme disparity in the education of the intellect and of the sexually based emotions. Such a disparity does not commonly arise, because there are many unintended casual human experiences, outside the education of school or tutor, which call out reactions on the emotional side of consciousness. What I do claim is that the sexually based emotions are commonly overlooked in any scheme of education (either because they have been traditionally ignored, or because they are inconvenient and puzzling to deal with), and that this is a serious mistake. The mistake

arises from the fact that these emotions represent a fundamental and essential biological fact, — the necessity of maintaining the species, — and that to ignore it in education is to overlook a force powerful for good or evil, and hence dangerous to pass by.

I do not consider it possible to formulate in an academic manner any general rules for the education of the sexually based emotions, for the reason that the psychology of these emotions is as yet too little understood. Yet it is possible for us to begin to think of this subject as one worthy of the recognition of parents and educators.

Before the ripening of the sexual glands, that is, before the time of puberty, the question of directing and educating the sexual instinct and the emotions based on it can hardly be said to arise. But with the physical maturity of boy or girl definite and complex problems arise in an almost abrupt manner. The outward signals that this time has arrived are characteristic for each sex, but boy and girl have at least one psychical feature in common — the growth of a new emotional life. This emotional life finds expression in a decline in interest in ordinary amusements and occupations, and a corresponding growth of interest in matters pertaining to the relations of the sexes, to courtship, love, marriage, social functions, etc. There is often a distinct lack of stability of the nervous system at this time, an increased self-consciousness, and a disposition to take a more serious, and often a more egotistical, view of life. There is

usually also a distinct growth of intellectual power, which may have its origin in part in the action of some internal secretion of the sexual glands on the nutrition of the nervous substance. In these various changes incidental to puberty there lies the basis of a distinct educational problem.

With the onset of puberty, and frequently even before this period, there awakens an interest in all matters having to do with the sexual functions. In each sex there are recurrent signs of the maturation of the generative organs, which cannot be ignored and which naturally cause the adolescent mind to be more or less occupied with the reproductive functions. The effect of these obtrusive physiological signals on consciousness is not the same in different persons, but depends upon the individual type of nervous system, and especially on the grade of intelligence, the type of sensibility, and the character of the inhibitions. In one adolescent, the sensibilities are so slight and the imagination so little active that the phenomena of sexual maturation are taken casually, with little or no disturbance of mental equilibrium, and no tendency to experiment with the newly developed powers. In another, the sensibilities are more active, and the sexual processes enter on the field of consciousness with greater obtrusiveness. Here there is necessarily a stronger tendency to liberate the sexual reflexes, and the failure to deliberately indulge the sexual appetite is due to the intelligent obedience to an instinctive

sense of propriety — or to put it in the language of physiology, to the control of lower nervous centers by the inhibitory action of higher ones. In cases of this sort, which represent common conditions among civilized peoples, this restraint of the lower by the higher centers is not accomplished without recurrent struggles, sometimes of an extremely trying kind. Finally there are individuals who have nervous systems that are hypersensitive and in whom the impulses that radiate from the sexual glands and other organs keep consciousness much of the time in a state of turbulent disorder. Strong intelligence and strong inhibitions are needed to restrain the sexual reflexes from being put into deliberate action, and if these be inadequate, there exist the conditions that favor a life in which sexual dissipation is a prominent feature. And thus it is clear that the character of the nervous system is a potent factor in determining the tendency of the adolescent with respect to sexual morality. A wider recognition of this fact will help to make people more tolerant of the sexual errors of certain types of persons, at the same time that it will aid in strengthening the inhibitions which are required to turn the scales in the direction of a reasonable practice of continence.

It is customary for parents and teachers to avoid all reference to the sexual problems that arise in their children or pupils at the time of puberty. The reason which is given for this ignoring of a vital function is that any discussion of it will tend to promote

self-consciousness and a detrimental dwelling on a subject which ought to be kept in the dark. It is true that this is in many cases a prominent motive of parents in ignoring the sex problem. But this motive is often conjoined with another — the painfulness to themselves of attempting to discuss a subject so difficult and so distasteful. As a result of this attitude on the part of parents their children are commonly deprived of very important help which might be given them. This is, however, the very point on which people disagree — some contending that there is nothing to be done, others holding that the rational enlightenment of adolescent children is almost certain to result in benefit to them.

It is certain that the nervous systems of some young people require more protection than others in the direction of enlightenment designed to bring about a better control of the sex instinct; it is equally certain that all normal nervous systems need such help in some degree. This help should come from the parents rather than from hired teachers, but it is better that it should come from teachers than that it should not come at all. It should come from fathers to their sons, and from mothers to their daughters, but if conditions do not permit this ideal relation, the father should be prepared to help his daughter, or the mother her son. And what shall they teach, and how shall they teach it? Although volumes might be written in answer to these questions, there are a few principles that may be looked

upon as safe guides to follow. One is that the need of each child is individual, and can only properly be satisfied by a knowledge of his or her personality and intelligence. Another is that no intelligent or sincere question put by the child should be left unanswered so far as the parent is able to answer it. And while it is in general wise to discourage discussions of the grosser and more intense phases of sexual passion, I would not say that even these are unfit subjects, provided the adolescent child has a high degree of intelligence and good moral intent (purpose). Questions involving problems of sex are often put by children to their parents long before the age of puberty is reached, and hence before there is need for precise knowledge of human sexual anatomy or physiology. Many wise parents introduce young children to the idea of sex by resorting to the processes of fertilization in plants, and this is, in many ways, an admirable method. If such studies lead to embarrassing interrogations about sex questions or relations, in domestic animals, as horses or dogs, these need be answered only in part, and in a superficial yet truthful manner, the justification for this lying in the fact that fuller explanations cannot be really apprehended. Lastly, it cannot be too strongly impressed on the mind of every young child that the sexual instinct is in itself nothing to be ashamed of, but that it is, on the contrary, possessed of the highest biological and sociological dignity. At the same time it should be made clear that whatever is really shameful

depends on the abuse, and not on the right use of these functions. And it is also wise to make it clear that the tendency to reticence in regard to all that concerns sex springs from the intensely personal character of sexual experiences, and in this respect is not different from reticence in regard to other intense emotional experiences.

Whatever there may be of truth and justice in these recommendations, they tend to break down in practice on account of the difficulties in carrying them out. For it may be justly asked, Where are the parents to carry out this kind of education? Aside from a few exceptionally cultivated and intelligent mothers and fathers, there are at present almost no adults who have had the necessary training to give them the right point of view for a task that calls for the knowledge, refinement, tact, and personal insight and sympathy with child life which alone can render them competent for this extremely difficult and trying type of human service. The future must provide such parents in increasing numbers, until they become a telling factor in the elevation of the race. But the education of adolescent children in the physiology of sex is only one part of the duty of parents and teachers in respect to education based on the needs of the instinct of race preservation. This wider racial education necessitates, in a measure, a training of intellect, but it is in an equal degree dependent upon a development of the emotional side of human nature. The fundamental thing about

this wider education is its dependence on the idea of sacrifice — the sacrifice of certain personal desires of self-preservation deliberately made for the sake of affection or generous emotions based on the pleasure or welfare of those with whom there exist ties of affection or friendship. This phenomenon of sacrifice is seen in its typical form in the relation of the mother to her child, and in a lesser but still significant degree in the relation of the father toward the family for which he provides, in the feelings of children toward their parents, in the readiness of lovers to suffer for each other. There is little reasonable doubt that it is the extension of this willingness on the part of people, at some time in their lives, to make sacrifices of their freedom in certain directions that constitutes the most active humanizing influence of the world. In other words, the sexual instinct which underlies this affection is an extremely powerful force in the construction of civilized society. It operates through highly complex emotions which often defy analysis by the methods of psychology, and the elementary sensations on which it is based are often mingled with much more elaborate æsthetic sensations. Among highly cultivated persons, with a talent for introspection upon emotional experiences, there may be a high degree of self-education as to the nature of these experiences. The majority of young persons do not possess this power of self-education. It is, therefore, necessary that they should be helped, by persons who understand their

temperaments and individual reactions, to understand, to develop, and to control this important side of their nature.

The objection will doubtless be raised that there are grave risks attendant on the deliberate instruction of children in matters relating to the sexual side of life, especially the risk of inviting the mind to dwell on functions, both physical and psychical, which should be permitted to unfold themselves automatically and unconsciously. But this method of *laissez faire* has been given a full trial, and its results have been incalculably bad. There is no gainsaying the fact that the human animal requires education in respect to the racial instincts. Whatever drawbacks there may be from rendering children more thoughtful in regard to their personal physical functions must be risked, for they are incomparably small when contrasted with the risks of leaving to chance the development of this side of life. And it may be said with confidence that when this education and guidance of the racial instinct is intrusted to intelligent and sympathetic parents, the results are almost uniformly good among children free from degenerative stigmata.

The beneficial results of a greatly improved system of education which shall recognize the necessity of the development of the racial as well as the self-preservative instincts may be predicted to be of the highest significance for the future. While the education of the self-preservative instinct has to do

mainly with the intellect, and the education of the racial instinct more largely with the emotions, it is, of course, apparent that there can be in practice no sharp separation of the educational processes that relate to the intellect and the emotions, but that both must proceed by parallel efforts. The sum of these efforts cannot fail to result in a fuller development of the possibilities of the individual nature than has hitherto been the case. And it is clear that this fuller development can lead only in one direction — namely, toward a greater proportion of enlightened altruistic conduct among human beings.

CHAPTER XIII

THE FRUITS OF EDUCATION

We may sketch very briefly some of the obvious results and accompaniments of the more thorough and comprehensive educational opening up of physiological paths. Among the beneficent results and associations to which we may confidently look forward are an improvement in the position of women, changes in the distribution of the profits of business, changes in methods and ideals of government, a great extension of the activities of science and of art, and some radical changes in the attitude of religious teachers.

I

Probably no single social factor has so powerful an influence in determining the progress of a nation toward higher ideals as the position of its women. At present no civilized nation can boast of anything like an equality of its women with its men, in respect to education, culture, efficiency, in practical life or moral tone. Even in the United States, where there is probably less difference between the sexes in these important respects, the general superiority of the men

cannot be questioned. We do not have to seek far for the reason of this inequality. The history of the human race shows that women have always been subjugated by men and have never escaped entirely from this bondage. To-day their bondage is less irksome and less palpable, yet it still exists in quite well-defined forms. The male members of the family control the means of subsistence, and so long as this is the case, the lack of independence of the women is reflected in various ways. Most women submit readily to this male control of the finances, or even encourage it, for it has so long seemed natural and proper that few would dare question it. Nevertheless, this acquiescence has many drawbacks tending to make or keep women relatively helpless and therefore relatively servile in their position toward men. The fact that women are often indulged by their husbands in every luxury, however whimsical, is not a valid argument against the objectionable tendency to subjection that is exerted through the regulation of the purse strings.

The disabilities of women as compared with men are commonly regarded with complacency, for they are ascribed to inherent differences of a sexual nature which cannot be eradicated, and which it would not be desirable to efface were it possible. No one can deny that there are natural differences of a very important kind between men and women. Women appear, in general, to be more emotional than men, more ready to make personal sacrifices

on account of affection and less efficient and constructive in the affairs of the intellect. But we yet know but little of the fundamental differences in sex psychology, and a grave difficulty in the way of acquiring this knowledge is the fact that nearly all the subjects available for observation have been so differently environed as the result of custom, according as they are male or female, that comparisons of natural faculties are much obscured. The result is that we cannot state confidently how much the superiority of men is due to natural and fixed causes and how much to social and modifiable causes. There is good reason to believe that great and real as are the natural differences between men and women, they are far from explaining the differences which are actually in evidence in society as it is at present constituted. In other words, there exist differences which must be due to the educational and environmental influences which have discriminated unfavorably against women.

We may predict with considerable confidence that the future will show increasing numbers of women who have had educational chances, not inferior to those of men, for the development of character and talent. Some of the predictable results of these improved opportunities are self-evident; others are less frankly obvious. Some of these results have to do with the family relations of women, for education cannot fail to make women better companions for their husbands and better guides and models for

their children. A more intelligent interest on the part of women in the business or professional affairs of their husbands cannot fail to strengthen family ties and the solidarity of the family. Women should have a better knowledge of the methods of gaining money and could exert a powerful influence to prevent men from resorting to questionable practices. Too often forgot is the advice of the not over idealistic Bacon, "It is better to curtail small expenditures than to stoop to petty gettings." The wife here may play a fateful part. This influence for good is but too often lost, owing to ignorance or disregard for the husband's financial methods and resources. But this influence of the wife over the husband's career may be far more subtle, for it may extend to a deep interest in the occupation for its own sake. There is certainly no profession and perhaps no business which has not its ideals, and attainment of these must often depend on the encouragement that a man gets at his own hearth, where too often there is no inspiration but only sordid or idle thoughts, arising quite as frequently from poor training and inferior understanding as from unworthy intentions. In just such relations as these is most to be expected, from those men and women whose emotional life has had the benefit of intelligent guidance and control. And equally great and fateful is the effect on the rising generation. The mother who unites a firm will to the cultured intelligence that comes of education will fashion worthy citizens, capable of doing good

rather than bad, capable also of growing into centers that radiate those influences that advance the professional and business ideals which are so much more necessary to a country than mere ease and elegance in living. Moreover, the educated mother has it in her power to better the relations between parents and children. Parents have yet to awaken to the full extent of their responsibility to their children. When they do so, they will learn to purify their actions, so as to live in the interests of the new lives rather than in their own interest; and this will include a growing readiness to make sacrifices, personal and monetary, for the sake of their future representatives. It is essential that parents should learn to abdicate in many directions in favor of their children and to eliminate all sense of rivalry with them. This is the right course because it is the biological course, and the world will be greatly improved when this fact comes to be recognized and parents cease to exert the tyrannies of affection that spoil so many young lives by robbing them of opportunity. The unconscious selfishness of parents to their children is one of the great evils of society which can only be cured by education, and especially by the education of women. There is no danger but that the sacrifices of parents for their children are usually more than recompensed by the affection of the children. Where children show ingratitude, this is a serious reflection on both heredity and bringing up, and this responsibility again falls on the elders.

The possibility of women entering upon serious callings is now no longer a matter of dispute, but in the case of every intellectually ambitious married woman, the question comes up, How far am I justified in leading an independent life, with interests not directly related to husband and children? There can be no doubt that society would be the gainer if more women could have active and independent artistic, literary, scientific, or humanitarian interests, and it is also quite clear that thousands of women who now dissipate their energies in time robbing and meaningless frivolities could find the time necessary to accomplish something worthy in one of these directions. This is in no wise in opposition to the obvious truth that for most women the most productive activities are those that have to do with the making of a home. But where there is a will there is a way, and really gifted and spirited women are wholly justified in struggling to find an outlet for their powers, if they have confidence in them, for in this way society in general may become a great gainer. Not only does such a course not involve neglect of parental duties, but it may have a distinctly beneficial effect in the family, both by setting an example of earnest effort and by widening the experience of the mother. But where the interests of the home and the outside interests are in opposition, right feeling will naturally tend to make the mother give up the latter for her family, unless, indeed, they have acquired great public importance.

The improved education of women must in time earn them the right to vote. That it is to the interest of any community to grant its women this privilege seems hardly a question for discussion. In most families the responsibility of rearing the children is left mainly to the mothers, and it is not consistent to maintain that women who are fitted to rear the future citizens of a country are unfit for its elective franchise. A country can ill afford to be without the political interest of its educated women, for there is no good reason to think that, once emancipated from the largely artificial state of permanent intellectual childhood in which they are now kept, they would not exert as beneficial an influence in political life as men. That their sex should give them a somewhat different point of view from that of men can hardly be regarded as an objection, but is rather an advantage, as it would tend to introduce new elements of human feeling and thought and aspiration. There should, however, be a moderately high educational qualification for the franchise and possibly a small property qualification, though this is really equally necessary in the case of men. A nation that has sacrificed a million lives in the course of a struggle resulting in the emancipation of the negro, and that allows its most debauched, semi-criminal classes to vote, cannot deny its vote to its best women without being guilty of an unpardonable thoughtlessness.

The world looks with dislike and distrust at the

pretense of educated people, and is particularly severe in its judgment of women who have become pretentious in the course of the educational process. But it is hardly fair to blame education for the appearance of this defect in character either in women or men. The education that makes for pretense is at best a half education, dealing too much with the routine processes of memorization and too little with the real understanding and the finer feelings. A true and balanced education, while strengthening the quality of self-reliance, must tend to inhibit the overappraisal of self by showing more and more clearly how little is attainable by one individual in comparison with the range of human knowledge and capacity. It may, perhaps, be successfully maintained that the education of women, as of men, often operates to make them less contented with themselves and with their fate, but it is hardly just to attribute to sound education the development of pretense and egotism.

The refinement and control of the sex impulse, which I have described as one of the most significant evidences of advancing civilization, has been associated with what western nations regard as an improved condition in the status of women. In some countries, notably in the United States, the extreme license of women and the exactions often practiced by them on their husbands, parents, and children have led thoughtful people to wonder whether the male sentiment and generosity which have made

this great freedom possible are not in some danger of being abused. Most cultivated Americans would probably answer this question by saying that it is worth risking something in the way of abuse of the freedom of women to preserve the good spirit of equality that has made this possible, and they would probably hold this opinion the more strongly if they had seen the discouraging limitations of reasonable liberty that exist in the continent of Europe. There is, however, a different point of view in regard to the attitude of occidental man toward woman, a view which has been so well pictured by Lafcadio Hearn in his essay on "The Eternal Feminine," and which cannot be ignored. It appears that in Japan many impressions of life have emerged from ancient habits, ethics, and beliefs, in some cases singularly opposed to those of the Anglo-Saxon race. The attitude of the oriental and of the occidental is in nothing more different than in the way in which the men think of women. The reverence, the tenderness, the exaggerated symbolism expressed in poems and novels of the West, is unintelligible, it seems, to the Japanese. Filial piety is the moral cement of his social system, and it appears to him wholly unnatural to love his wife and child as much or more than his parents. "To the young Japanese marriage appears a simple, national duty, for the due performance of which his parents will make all necessary arrangements at the proper time." The Scripture text, "For this cause shall a man cleave

unto his wife," appears to the Japanese one of the most immoral sentiments ever uttered. Mr. Hearn tells us: "The reserve of Japanese literature regarding that love which is the great theme of our greatest novelists and poets is exactly paralleled by the reserve of Japanese society in regard to the same topic. The typical woman often figures in Japanese romance as a heroine; as a perfect mother; as a pious daughter, willing to sacrifice all for duty; as a loyal wife, who follows her husband into battle, never as a sentimental maiden, dying, or making others die, for love." It would not be fair to infer from this oriental relation of man and woman that the man does not love his wife. The Japanese may love his wife; in fact, it is his duty to love her. But affection must be subordinated to duty, and is actually so subordinated.

That there accrue to a nation very distinct advantages from the existence of social ideals which place duty to parents and the state above all else, is a proposition which might be strongly defended. On the other hand, the successful maintenance of this attitude leads the Anglo-Saxon to suspect that the Japanese must possess a nature relatively thin in many finer emotional qualities built on the sexual instinct — a nature which has never acquired the somewhat dangerous instability which at least during short periods makes it possible to make extreme sacrifices for a love far more spiritual than physical in its character. The poverty of Japanese emotional

poetry and the primitive nature of Japanese music — the two media for the expression of love — go far to bear out this idea.

With these differences between the occidental and the oriental nature there is inseparably linked a difference in the fundamental constitution of society which possesses a deep biological significance. It is that the feudal structure of oriental society, expressed in the fact that society (in the special sense of the word) still remains masculine, has brought about a complete inversion of the legitimate biological trend of the national development. This masculine structure of society, and the traditional subordination of the interests of children to those of their parents, combine to bring an element of rigidity and hardness into the national life. Filial piety is an admirable trait, but the exaction of it by the parents is far less admirable and may easily become a highly objectionable feature. Biologically speaking, the responsibility of parents for their children is far greater than the responsibility of the children to their parents. Without parental help children must inevitably die, being wholly dependent. But parents may live without filial aid and seldom depend on it until relatively late in life. There is a tendency everywhere for parents to use the irresistible leverage which their parental relation gives them, to mould their children to their own ends. To exact some services in return for those given, is natural and helpful to the character of the child, but the

demand made on the child may easily become excessive and thus stand in the way of its development. This happens often enough in European countries, but in Japan the subordination of the interests of the children is part of a stereotyped system which no one dares to question. Parents accept sacrifices from their children which they have no right to demand, and this course is none the less reprehensible because the sacrifices are willingly made. The oriental looks to the past and not sufficiently to the future; but nature looks to the future, and the future belongs to the young generation and not to the old. The nations which do not give their young the fullest opportunity to develop, unhampered by arbitrary and excessive parental duties, must remain undeveloped intellectually and industrially in comparison with the countries that realize the possibilities of youth and the increased inherent advantage that each new generation has over the one that preceded it. But these advantages cannot be secured to children except as the result of the most enlightened family life, where the mother, as well as the father, coöperates to give the children every opportunity for mental, moral, and physical growth, even when this entails great personal sacrifices. In countries like China and Japan the family life that leads to the fullest, most unhampered growth of the children is something unknown. I consider that the reason that such growth is there impossible is because of the absence of those higher and more subtle relationships

between men and women that lead to the finest ideals of family life. In other words, the refined sexually based sentiment, which the oriental cannot understand and which he regards with aversion, becomes a subtle but potent influence in securing the freest and best development of the young. It is thus a biological factor in bringing about the highest type of civilization, if we may apply this term to that progress which allows the freest play to the highest intellectual and moral faculties of man.

II

A tendency clearly discernible among the nations most advanced in civilization is a growing dissatisfaction with existing economic conditions, which is already showing itself in legislative and executive measures designed to correct some of the most distasteful of these conditions. Among the things that have called forth the most active criticism and hostility is that uneven distribution in the profits of business which has built up fortunes so great as to excite the liveliest interest and even admiration on the part of the disapproving and often semienvious populace. The most conspicuous of these fortunes have arisen in the United States, where favorable natural conditions have given scope for the accumulative talents of many men of extraordinary aggressively constructive or executive ability, and it is here that restrictive measures are now being most

actively agitated. The hostility felt toward these rich men is by no means confined to them, but includes thousands of other men who have attained business successes by opportunities, methods, and talents similar to those of their more conspicuous and more wealthy prototypes. It is doubtless true that the use of harsh or even dishonest methods of business and of artificial advantages, such as rebates and a high protective tariff, have contributed to the widespread unpopularity of many of the most successful American business men. It is worth while to consider some present tendencies that will certainly lead to changes in the distribution of the profits of business and of property generally.

In all complex forms of civilization society is organized on an aristocratic basis, and has always been so organized. This holds true in the sense tha a relatively small number of individuals have obtained for themselves superior advantages in respect to wealth and political influence and the privileges which these can secure. The obtaining of these advantages depends in the final analysis on perfectly definite biological conditions; that is to say, on superiorities of physical organization inclusive of that superiority in the central nervous mechanism which is the substructure of intelligence, will, and character. In former civilizations wealth and political and military power held an even greater place in the aristocratic scheme than in the societies of to-day, for with the rise of literature, art, and science

— the formal expressions of the union of the higher racial instincts with those of self-preservation — the aristocratic structure was significantly broadened by the entrance of men who live rather for the sake of ideas than for things, and whose creations are not motived by the desire to gain the ordinary kinds of power over humanity. But even with the accession of this class, the number of those constituting the ruling classes, in the broadest sense, is small as compared with the entire population of any country. This aristocracy of power and intellect, whether we construe it liberally or narrowly, rests on and springs from a large mass of human beings who toil with so little return of intellectual or moral elevation, and with so few material or spiritual opportunities for themselves or their children that the inequality excites the pity and often the indignation of those who interest themselves in their social welfare. Innumerable plans and panaceas have been proposed to relieve these inequalities in the sense of improving the opportunities of the poorest classes, and the discontented elements are appealed to from every side to support policies and plans for their improvement. The great variety of the measures proposed is in itself an indication of the uncertainty of the remedies. It is in the highest degree doubtful whether any remedies can have a significant effect in the amelioration of the masses of any community which is not founded on an educational basis of which an enlightened self-control is the chief pillar. The

first practical aim in paving the way for real betterment must be the intelligent limitation of population through the curbing of procreation. Laws can probably never be relied upon to effect this; but what law cannot command, the human will may perhaps accomplish. Intelligence may in time act as a powerful impulse to limit families to a number that can be reared with care and opportunity. This cannot happen in a country short of labor, owing to the possession of extended undeveloped natural resources, but it may happen when the constant demand for rapid extension has slackened. Then, and only then, will the ideal of quality take precedence over the ideal of quantity in human affairs.

It is certain that under no plan of social organization can there be a disappearance of that stratification which has its basis in inherited and acquired biological advantages possessed by some individuals. Certain types of intelligence and character will always play a leading part in the life of a community and will constitute a plastic and changing aristocracy, and not necessarily a rigid one. On the other hand, the rough work of the world will always have to be done. There must be laborers on the farm, in the factory, and perhaps in the mines, and these will be recruited from the robust members of the least highly educated classes, though this deficiency in education may be much less pronounced than now and only relatively poor. But if the distinction between the aristocratic and protelarian classes cannot be wiped

out, owing to biological human inequalities which appear to be unendingly recurrent in nature, there are possibilities of much closer and better relations between the more favored and less favored strata than now exist. The initiative, in the effort to gain these better relations, must come largely from the more favored classes, although the organized action of laboring men within recent years has begun to be a potent influence for the insistence on certain kinds of recognition. There are several distinct though closely affiliated forces which, under the influence of broadening and deepening education, will serve, if any will, to secure the improved human relations which are so greatly needed, if the most intelligent and sympathetic thought of the relatively few is to be utilized in its most obvious and needed human application. First, the gradual utilization of the natural resources of countries will in time bring them into a state of approximate equilibrium and check their expansion in raw material. With this check in expansion must come a corresponding curb to the opportunities of able and venturesome promoters of industries. The lines of railways will have become established so as to require only minor extensions; the coal and iron mines will have become well known and their output carefully controlled; the banking facilities existent will have met the demands of business and will not widely vary in scope, at least within their own countries. Secondly, men of aggressive type whose ability has had full play during the ex-

pansive period will be forced to turn their powers into somewhat different channels. Original opportunity with its speculative chances will be curtailed and replaced by more systematic attention to the improvement of existing plants and fuller study of their needs and their relations to society. These important executive positions will be always among the most honorable and highly paid in the community, but they will be shorn of their capacity to greatly enrich, in the present-day sense, those who fill them. This curtailment of gross personal opportunity is in itself an educational factor which, when joined to increasing culture and the irrepressible spirit of democracy, must serve to direct the thoughts of forceful men more and more to the unending and subtle complexities of human affairs, and somewhat less toward purely mechanical problems. In short, it may be safely assumed that such men will not decline in vigor, but will rather redirect their energies into more directly humanizing channels. Finally, it is clear that the lower working classes of society, having once tasted the fruits of a higher standard of living than now prevails, with the opportunities for self-development that come from a share of leisure each day, will resist all economic tendencies that threaten these precious privileges. They will resent and resist, by means of the franchises which they are learning to use more and more skilfully, the importation of labor with lower standards of living, which those who are too eager for gain will always be willing

to invite under the excuse of stimulating industry. Whether the laboring classes will exercise intelligent restraint in reproduction for the sake of improving the opportunities for the best development of their children, remains to be seen. In the long run this is a question of ideals, and these, in turn, hang on character and education — the education of life, of things, and of books. There is no doubt that modern economic methods make possible for the laborer what was never possible in earlier days — some leisure over and above the time needed to make a living. All depends on the use to which this leisure is put — if it be to ignoble ends, there will come decadence; if to enlightened ends, there will come broadening opportunities. It is just in this vital decision that the upper classes can most effectively lend the weight of their influence toward that which is worth while. The encouragement of experienced, humane, and cultivated people is the leaven needed by the lower strata for their uplift. This is, in fact, the greatest of all opportunities of doing good of a permanent kind, and there are a thousand ways in which individual talents of helpfulness can be turned to social use. Will the upper classes of power, of intelligence, and of leisure one day see their chance, — as they have never yet seen it, — and seize the chance with enthusiastic determination to use it? Will they one day turn from the selfish, vulgar uses of time, to which so many devote their opportunity, and, taking the dynamic view of life, come to the aid

of the biological processes that make for human progress among the many for the limitation of suffering and the blotting out of such inequalities as natural conditions will allow? It is the highest privilege of the fortunate and educated man to take a part in modifying natural processes for the good of large numbers. And the future course of the white races must depend largely on the attitude of the powerful and fortunate towards the weak and less fortunate. It is no unreasonable hope that this attitude will grow infinitely more human and Christian than it has ever been, while the constructive human forces, at once the most subtle and most potent, will lead to a really new awakening — "consciousness the will informing, till it fashion all things fair."

CHAPTER XIV

CONCLUSION

It has been the aim of this essay to set forth a mode of thought regarding some of the problems of human life. It assumes that the human organism, like all others living on the surface of the earth planet, is a machine; and it assumes that there is no evidence that this machine is not a machine in all respects, like any engine which is the creation of man. The failure of known physical and mechanical laws to explain growth and the cell dynamics of reproduction cannot be construed as proof that these phenomena are extra-physical and extrachemical. Forces are at work in living beings which the mind of man has not compassed; but this is true also of the forces that are bound up with what we call inanimate matter. Energy is a feature of all matter, living or dead, and one of the most scrutinizing views of modern science identifies energy and matter in a manner which makes a powerful appeal to reason, though lacking in actual demonstrability. Certain it is that energy possesses the attribute of direction and persistence, and it is reasonable to think of combinations of different forms of energy in possession of direction inclusive of what we call matter, which we cannot now analyze into

their constituents (*e.g.* the healing of wounds). Such energy complexes may be answerable for the obscure behavior of protoplasm.

This mechanistic mode of thought cannot except the human mind from the sphere of dynamical operation. It looks on mind as the complex product of consciousness, and it looks on consciousness as a general function of cerebral neural action — especially such as is concerned with associative memory. The active, simultaneous, coördinated association of large numbers of cerebral cells is regarded as essential to the intense revival of memories of the outer world or that intense immediate reflection of the outer world which brings awareness of self. When once there has been attained the degree of awareness of self which enables the individual to separate himself distinctly from the rest of the world, the basis of thought has been laid and psychical progress in many directions is possible for the mechanism capable of effecting this distinction of self. Through the increasing practice and coördination of the neural elements of the brain more and more elaborated memories are stored and revived, and these memories are treated as the subject matter of thought and reflection. The fact that the dynamical nature of the physical and chemical changes that go on in the nerve elements in the processes built on consciousness is not understood need not disturb the belief that such changes, extremely subtle in kind, do actually occur. What especially concerns the biolo-

gist who interests himself in the psychical aspects of life is the recognition of the gradual evolution of these dynamical changes, and their relative incompleteness except in those most cultured and best organized human brains which we may arbitrarily accept as standards of what is possible of attainment. The significance of the incompleteness lies in the deceptions which the unbalanced and imperfect products of consciousness bring into existence — deceptions of sense and of mind which we have a right to proclaim as such by comparing the actions of inferior minds with the recognized best. For it is inevitable, and might almost have been predicted, that the individual and race endowed with consciousness should, according to varying organization, have developed excessive regard for the personality so strongly felt, the faults of egotism in many forms — before the corrections for this have been developed in the highest grades of cerebral action, *i.e.* the inhibitions based on superior understanding.

Many deceptions regarding the nature of human feelings and desires, the craving for immortality, the sharp separation of body and soul, the idea of free will, the food and sex impulses, have their origin in a too narrow range of the experiences of consciousness. Just as substances at very high temperatures develop properties quite unsuspected in common thermal conditions, so these feelings and desires assume new aspects when illumined by modern concepts of science. A distinction between the material

and the immaterial being no longer possible, why should we trouble ourselves as to distinctions between body and mind, matter and soul? We have been so deceived by continual association with solid objects as to gain highly distorted ideas in regard to what is called matter. Knowledge and imagination come to the rescue and reform our concepts.

Living protoplasm is endowed with two fundamental properties on which are based two whole series of instinctive actions in those organisms sufficiently advanced in organization to support expressive nervous mechanisms. The self-preservative instinct has its foundation in the power of individual growth, and the correlative need for food; the race-preservative instinct has its basis in the power of cell division — in the entire individual as for a special group of cells. The physical development of the central nervous system is influenced in important and probably specific ways by the somatic cells and by the reproductive cells, and it is not singular that the processes of ideation should also be influenced by the activities of these two groups of cells. The habitual life of the adult human being is dominated by self-preservative reactions, but interwoven with these are reactions based on the activities of the sexual cells — reactions at times capable of taking precedence over those of self-preservative origin. The content of the psychical life is built upon the elaborate though irregular felting of these two distinct types of reactions, and the patterns may become so complex as

to obscure the identity of the constituent strands. Æsthetic and religious emotions, for example, may show no obvious traces of their dependence on these instinctive elements without the aid of close scrutiny. The history of the development of the nervous system itself from unspecialized cells supplies a material analogy to the idea that superior mental states may arise from humble origins of unpredictable potentialities.

The psychical life of the normal individual is based on three kinds of experiences. Two of these have their origin in stimuli from the outer world, either from unorganized nature or from living beings. The stimuli derived from association with human beings are responsible for some of the most important formative processes of the human nervous system, and one may go so far as to say that the continual and multiplex interaction of nervous protoplasm — through the agency of what we call mind — is the prime environmental agency in the evolution of ideas and concepts. But the stimuli from the outer world are recorded physically in the neural structures, and these records are susceptible of revival from within the nervous system itself; that is, without the aid of new external stimuli. This third type of human experience, the revival of sensory impressions and of the mental states accompanying them, is the physiological basis of thought, imagination, reflection — or in other words, of psychical growth. Such revivals of sensory impressions are of course not limited to this inner origin, but are very generally initiated by stimuli through the sense organs.

We may reasonably think of the human nervous system as moulded, almost continually, by stimuli arising mainly through the agency of other human nervous systems. This powerfully moulding influence may be directly exerted, through speech and behavior, but among cultivated peoples is effectively reënforced by the indirect action of human records, as by art, music, or literature. As these records reflect the outer world of nature, as distinct from man, it may be truly said that much of man's knowledge of nature may come through human interpretation of it in lieu of direct experience. It is, indeed, a definite tendency of modern culture to exclude increasingly the direct appeal of nature and to accept as a substitute the experiences of other human beings with respect to it. Hence we may say of cultured races, at the present time more strongly than of any other, that the progress and fate of their individual members is in a high degree based on the neural interactions of these members. We have already seen that there is no satisfactory evidence of strict spontaneity of action on the part of human nervous systems or the individuals of whom they constitute the essence; but that, on the contrary, there prevails an automatism of transcendent delicacy, refinement, and complexity. This incomparable and superlative automatism is the expression of the extreme plasticity of the wonderful neural protoplasm which makes up the nervous system of man. The experiences of each human nervous system are so numerous,

so individual, in the ceaseless activities of life, that we are justified in looking at the mechanisms themselves as highly experimental and adaptive. Adequately to picture the play of stimuli and reactions capable of arising between two such nervous mechanisms would be a task defiant of human powers; how impossible, then, to draw, even in outline, the complexities that arise from that free intercourse of human beings which characterizes human life in modern communities? We are obliged to satisfy our legitimate interest, tinged with curiosity, by a concentrated effort of imagination, to arouse and revive or rather reconstruct a mental picture of the make-up of the nervous system and its ingoing and outgoing paths, while simultaneously endeavoring to think of the play of forces within these manifold structures during some definite state of activity. For some minds even this crude effort yields a degree of satisfaction, if it does no more than emphasize anew the impossibility of the stupendous task. Our failure to compass this undertaking need not blind us to the consequences that flow from the admission of the incomparable plasticity and ceaseless activity of the superior automatic nervous mechanism. If the behavior of one elaborate automaton influences that of another, the total behavior of an individual must be the sum of these interactions of nervous protoplasm of different brains with each other and with the outer world. According to this view we take no account of what is called freedom of

the will, for this is an illusory feeling, associated with necessary and inevitable protoplasmic reactions, excited by stimuli which, acting on a brain of given organization and experience, could have no other outcome except that which in fact transpired. If this view be reflective of the actual, we must regard the conduct and the fate of any race of men or animals as conditioned essentially by the nature of the protoplasm in which it had its origin and especially by the properties of its nervous protoplasm. We cannot predict the future of any race or any individual because we know neither what the environment holds in store, nor what are the inherent properties of the reactive protoplasm. The best we can hope to do is to predict that in a given set of conditions a race of observed traits will react in such a way as to reveal certain tendencies making for self-preservation or for destruction, for psychical improvement or for debasement. The future of any man or race of men is definitely predetermined in the protoplasm. But the environmental stimuli which evoke the reactions we call conduct are not of a chance nature; down to their minutest details they, too, are part of an inevitable system. Hence we cannot escape the conclusion that although man lives in the midst of a world having the appearance of almost infinite plasticity and uncertainty, his life unfolds itself with relentless rigidity in the midst of an equally fixed sequence of external phenomena.

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